

Audiometer Calibration System



User Manual



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IAUDIT.01 Rev. C

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Larson Davis will provide periodic updates to the software, which may include bug fixes and enhancements for a period of two years from the purchase date.

Please retain the model number, serial number, and purchase date for each component of your audiometer calibration system. You may be asked to provide this information when contacting Larson Davis for service or technical support.

Acknowledgments

The three dimensional model of the human middle ear on the splash screen was created in the laboratory of R. Funnell (Department of Biomedical Engineering, McGill University), based on magnetic resonance microscopy data obtained from M. M. and O.W. Henson (Department of Cell Biology and Anatomy, University of North Carolina). MR microscopy was carried out at the Center for In Vivo Microscopy (an NCRR National Resource; G.A. Johnson, Director) at Duke University Medical Center. Used by permission.

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1681 West 820 North

Provo, Utah, USA 84601

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Welcome to AUDit™ Audiometer Intelligent Testing

Welcome to the Larson Davis system and software for audiometer calibration. The Larson Davis audiometer calibration system has been designed for simplicity, portability, and durability. System weight, volume and component count have been carefully managed. This provides you with a complete solution for in-house or in-field audiometer calibration without sacrificing accuracy and stability.

Your audiometer calibration system uses the System824 next generation precision sound level meter to maintain and exceed the performance of previous Larson Davis Model 800B-based systems. The System824 possesses numerous analysis features which make it ideal for audiometer calibration:

- large dynamic range - allows accurate measurement of linearity and level in the minimum period of time
- digital signal processing - makes highly precise fractional octave, pulse, and FM measurements possible
- precision frequency counter - permits audiometer frequency measurement without additional instrumentation
- narrowband analysis mode - enables quick measurement of total harmonic distortion, bandwidth, etc.

Furthermore, the software has been enhanced with the following features:

- a whole range of transducers, their corrections and limits have been implemented, including: circumaural, supra-aural, insert earphones, bone vibrators, and speakers.

- a measurement database search allows quick reference to previously calibrated audiometers to speed up test configuration or compare the current test with historical data
- extended frequencies can be tested using appropriate couplers (such as the new Larson Davis AEC101 IEC 318 coupler and plates)

AUDit™ software is compatible with Windows™ 95 and Windows™ 98 type operating systems running on PC compatible computers.

We invite you to read this brief manual to get the most out of your audiometric calibration system. Additional information on the System 824 precision sound level meter and other system components may be found in their respective documentation.

About This Manual

This manual will cover the following topics:

- *Chapter 1* - Introduction: system overview, components, and software installation.
- *Chapter 2* - Initial System Configuration: entering test instrumentation and other preferences.
- *Chapter 3* - Audiometer Test Setup: entering information regarding audiometer and transducers to be tested.
- *Chapter 4* - Booth Test/Ambient Noise Level Test: audiometric booth verification.
- *Chapter 5* - Assembly of the audiometric calibration system.
- *Chapter 6* - Hearing Level Test: transducer output calibration in dBHL.
- *Chapter 7* - Frequency Test: output frequency calibration.
- *Chapter 8* - Linearity Test output attenuator linearity calibration.
- *Chapter 9* - Distortion Test: Total harmonic distortion measurements.

- *Chapter 10* - Pulse Tests: verification of pulsed tone capability.
- *Chapter 11* - Cross Talk Test: measurement of leakage between test and non test transducer.
- *Chapter 12* - Frequency Modulation Test: FM tone characteristics such as carrier frequency and modulation.
- *Chapter 13* - Narrow Band Level Test: narrow band noise stimulus calibration.
- *Chapter 14* - Broad Band Noise Masking Test: level and spectral flatness of broad band masking noise are verified.
- *Chapter 15* - Speech Test: calibration of speech presentation facilities.
- *Chapter 16* - Audiometer Test Notes: component and accessory visual and functional inspection.
- *Chapter 17* - Reports and Data Base functions: hard copy output and stored measurements.
- *Chapter 18* - 824-AUD Firmware Overview: manual operation of audiometer calibration features of System 824.
- *Appendix A* - Artificial Ear Technical Specifications
- *Appendix B* - 824 Technical Specifications
- *Appendix C* - Sample Reports
- *Appendix D* - Glossary

About This Chapter

This introductory chapter covers the following topics:

- **Formatting Conventions:** explanation of the fonts and other formatting conventions used in this manual
- **Unpacking and Inspection:** list of system components, documentation, etc.
- **Getting Started with AUDit™ Software:** installing the AUDit™ software on your PC

Formatting Conventions

This manual uses the following formatting conventions:

User Input: this bold sans-serif typeface indicates values or selections entered in the software

Screen prompts: this bold italic typeface denotes menu items, prompts, messages, and other textual information reported by the software.

Unpacking and Inspection

If you have received this manual as part of a complete Larson Davis audiometer calibration system, this section will acquaint you with its components. Your order has been shipped in protective packaging. As most audiometer calibration hardware must be recertified on an annual basis, please try to save these packing materials for future use.

Warranty Registration and Client Survey Cards

Customer satisfaction is extremely important to us all at Larson Davis. The quality of our products is backed by an industry leading warranty and customer service capability. Please assist us in providing you with the best service by completing the warranty card sent with your shipment. These may be returned to Larson Davis Customer Service, 1681 West 820 North, Provo, Utah USA 84601-1341.

Important: *If your packaging was damaged in transit, please contact your shipping provider for instructions on filing a claim.*

Please compare your system with the checklist below and note any discrepancies before contacting your Larson Davis representative:

SYS009 Audiometric Test System with Artificial Mastoid

Part	Description
2575	1 inch precision pressure response microphone, and case
System824	precision integrating sound level meter including PRM902 1/2 inch preamplifier with 7 pin LEMO connector PSA026 90-264 Volt to 12 V Power supply. 0277.0003 nickel metal hydride AA rechargeable battery pack CBL002 serial printer cable (with 25 pin D connector) CBL006 serial communications cable (with 9 pin D connector) CBL042 stereo phone plug to dual BNC output cable D2140.0006 client survey D2140.0007 warranty card I824.01 operator manual I824.02 training manual I824.03 firmware upgrade instruction sheet SWW 824 utility software diskette WS001 - 3 1/2 inch foam windscreen firmware diskette(s) with 824 internal code
824-AUD	audiometric test (internal) 824 firmware option
ADP006	BNC to 1/2 inch preamp thread adaptor with equivalent 47 pF capacitance for direct input to 824
ADP008	1/2 inch preamp to 1 inch microphone thread adaptor
ADP010	audiometer earphone adaptor for electrical input to 824
AEC100	artificial ear (NBS-9-A coupler) with base, coupler, retaining ring, microphone cap, mass and handle, and pillow
AMC493	artificial mastoid coupler and case IAMC493.01 AMC493 operator manual MMAS493.03 additional mass
CAL250	precision microphone calibrator with 1 inch opening including D2140.0007 warranty card I250.1 operator manual
CCS007	large weather-tight hard carrying case
EXA010	10 foot microphone extension cable
SWW_AUDIT	audiometer calibration software including IAUD.01 software operator manual and media

SYS008 Audiometric Test System

This system has the same components as the SYS009 with the exception of the AMC493 artificial mastoid.

Part	Description
2575	1 inch precision pressure response microphone, and case
System824	precision integrating sound level meter including PRM902 1/2 inch preamplifier with 7 pin LEMO connector PSA026 90-264 Volt to 12 V Power supply. 0277.0003 nickel metal hydride AA rechargeable battery pack CBL002 serial printer cable (with 25 pin D connector) CBL006 serial communications cable (with 9 pin D connector) CBL042 stereo phone plug to dual BNC output cable D2140.0006 client survey D2140.0007 warranty card I824.01 operator manual I824.02 training manual I824.03 firmware upgrade instruction sheet SWW 824 utility software diskette WS001 - 3 1/2 inch foam windscreen firmware diskette(s) with 824 internal code
824-AUD	audiometric test (internal 824 firmware option)
ADP006	BNC to 1/2 inch preamp thread adaptor with equivalent 47 pF capacitance for direct input to 824
ADP008	1/2 inch preamp to 1 inch microphone thread adaptor
ADP010	audiometer earphone adaptor for electrical input to 824
AEC100	artificial ear (NBS-9-A coupler) with base, coupler, retaining ring, microphone cap, mass and handle, and pillow
CAL250	precision microphone calibrator with 1 inch opening including D2140.0007 warranty card I250.1 operator manual
CCS007	large weather-tight hard carrying case
EXA010	10 foot microphone extension cable
SWW_AUDIT	audiometer calibration software including IAUD.01 software operator manual and media

Optional Components

- AEC101 artificial ear for extended frequency measurements (IEC 318 coupler)
- 2559 1/2 inch precision random response microphone, and protective case

Getting Started with AUDit™ Software

This section covers installation of the AUDit™ software and other important information including:

- Hardware and software required to run AUDit™
- Custom installation of the software
- Uninstalling the software

Hardware and Software Requirements

The following table lists the requirements for the installation and use of the AUDit™ software for audiometer calibration.

- Processor: Intel™ Pentium 90 processor or higher
- Operating system: Windows95™ or Windows98™
- Network: AUDit™ is not designed to work on a distributed network from a network drive. However, it may be operated from a local installation on a computer connected to a network.
- System Memory: 16 MBytes minimum
- Hard disk space: 5 MBytes minimum
- Communications: One available 9-pin serial communication port, 9600 baud or greater recommended
- Peripherals: 3.5 inch high density floppy disk drive, VGA or higher resolution monitor, Windows™ 95 or 98 compatible mouse or other pointing device, and printer for hard copy

Installation Options

Few installation options exist with the AUDit™ software. You may choose to:

- install AUDit™ in a destination folder other than the standard folder (C:\Program Files\Larson-Davis\AUDit™)
- place its program icon in a program folder other than the standard folder (Larson Davis Programs)
- change the name of the default database

If you have installed AUDit™ in this fashion, please make note of the locations and names of the components of AUDit™ for future reference.

Getting Help

Contact Larson Davis Technical Support at (801)375-0177 if you encounter any problems with the installation or use of the AUDit™ software.

Installing the Software

It is recommended that all Windows programs or tasks be ended before installing the software. Verify that the hardware and software requirements listed above are met before proceeding.

NOTE: If you have a previous version of AUDit™, it should be uninstalled before installing the current software. Go to the Uninstalling the Software section before proceeding.

Step 1 Put disk 1 of AUDit™ software in your 3.5 inch floppy disk drive. Click on **Start** on the desktop task bar.



Figure 1-1 *Windows™ Start Button*

Step 2 Select **Run**, then enter **a:setup**, replacing **a** with the appropriate drive letter, if necessary, and then select **OK**.

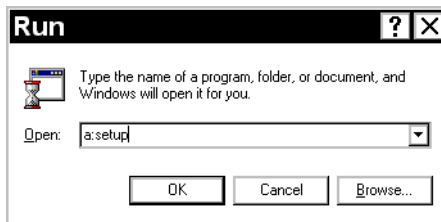


Figure 1-2 *Windows™ Run Dialog Box*

NOTE: If an initial instrumentation database file has been provided with your system, copy the database file (AUDinit.mdb) into the desired location.

Step 3 Follow the instructions of the setup program to install the program files in a specific folder. The default destination folder is **C:\Program Files\Larson-Davis\AUDit™**. Program icons

are added in the default program folder *Larson Davis Programs* of the *Programs* item in the *Start* menu.

Uninstalling the Software

Deleting the program files, program menu entry, and desktop program icon is easy.

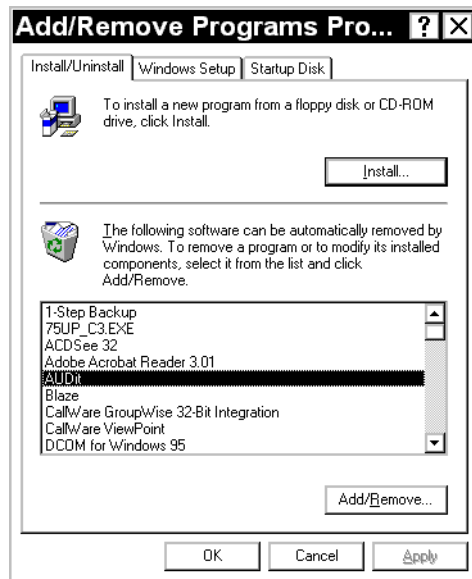


Figure 1-3 *Windows™ Add/Remove Programs Dialog Box*

- Step 1** Click *Start, Settings, Control Panel*, and *Add/Remove Programs*.
- Step 2** Highlight *AUDit* in the program list and click *Add/Remove*.
- Step 3** Follow prompts during the delete procedure.

Starting the software

- Step 1** In the Windows™ *Start* menu, select **Programs**, go to the folder which contains AUDit (**Larson Davis Programs** is the default) and select it. If this is the first time you have used the AUDit™ software, you will be asked if you wish to create a new database.

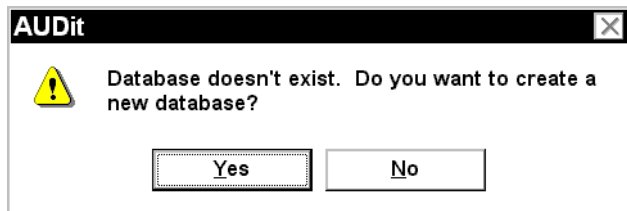


Figure 1-4 *Create new database Dialog Box*

- Step 2** Selecting **Yes** will create a database named **Auditdb.mdb** in the current default directory. To create a database later in another directory, select **No** at this time.

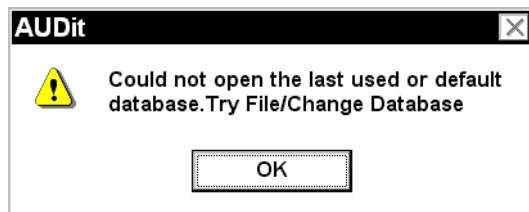


Figure 1-5 *Could not open database Dialog Window*

- Step 3** You will be able to enter a database name and directory in the **File, Change Database...** menu item. Press **OK** to acknowledge the prompt and display the main menu.

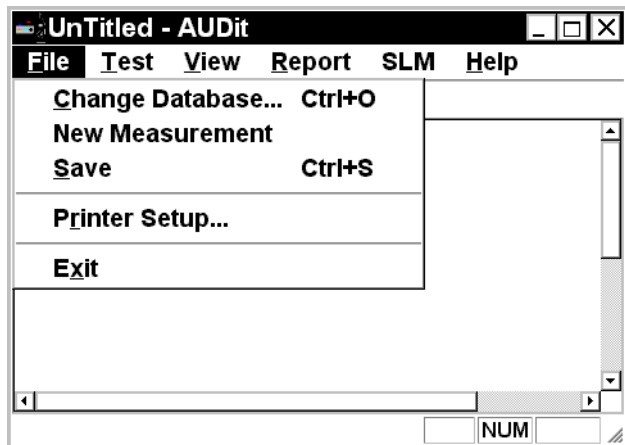
Software Overview

Main Menu Bar And Navigation

*NOTE: Wherever stated, a combination of keys can allow direct access to a certain function, for example **CTRL+O** brings up the Change Database dialog box.*

The main screen menu bar lists six items. Following standard Windows™ convention, these pulldown menus may be accessed with the pointing device or by simultaneously pressing Alt and the underlined letter. The left and right cursor keys also allow navigation through the menus, while the up and down cursor keys highlight the various pull down menu options listed below.

Menu selections which are invalid under certain circumstances may be grayed out. For example; until serial communication with a System824 sound level meter (SLM) has been established, the **Check Battery...** selection is unavailable.



File Menu

Figure 1-6 *File, Change Database Menu*

Change Database... Ctrl+O: Select the measurement database which will be used to store instruments, calibrated instruments and other test information

New Measurement: Begin a new measurement

Save Ctrl+S: Save the current test information in the measurement database

Printer Setup: Setup the printer which will be used for hard copy output of reports and certificates

Exit: End the current test and exit the software

Test Menu

Audiometer Test... Audiometer Test Notes... Booth Test...
Instrumentation... Preferences...
Stored Measurements

Figure 1-7 *Test Menu*

Audiometer Test...: Begin an audiometer test sequence

Audiometer Test Notes...: Enter notes on audiometer visual inspection and other comments

Booth Test...: Begin a test of the audiometric booth or audiometric examination area

Instrumentation...: Enter model, serial and correction information for the test instrumentation used in audiometer calibration

Preferences...: Define calibration organization name, address, etc. and set RS232 parameters for communication with the test System824 sound level meter

Stored Measurements: Search database tests by technician name, audiometer model, serial number, and test date

View Menu

<u>M</u>easurement Summary
✓ <u>T</u>oolbar
✓ <u>S</u>tatus Bar

Figure 1-8 *View Menu*

Measurement Summary: Display a status screen listing performed tests and other information about the current calibration

Toolbar: Show or hide the toolbar

Status Bar: Show or hide the status bar at the bottom of the AUDit™ window

Report Menu



Figure 1-9 *Report Menu*

Report...: Display the audiometer calibration report

Certificate...: Display the audiometer calibration certificate

Export...: Export the audiometer or booth test report to a file (depending on which type of measurement is current)

SLM Menu

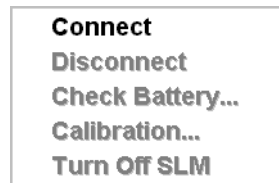


Figure 1-10 *SLM Menu*

Connect: Initiate communication with SLM on the serial port defined in *Preferences*

Disconnect: Terminate communication with the SLM

Check Battery...: Verify battery or external power voltage of the SLM

Calibration...: Calibrate the SLM and its microphone transducer

Turn Off SLM...: Power down the SLM

Help Menu



Figure 1-11 *Help Menu*

About AUDit™...: View revision, credits and other software information

Icon Bar



Figure 1-12 *Icon Bar*

This quick reference tool bar allows direct navigation to a set of most useful screens and functions of the AUDit™ software. Its icons are listed in the order which the functions are normally used in an audiometer test or calibration. In order, these icons are:

- New Measurement
- Retrieve Test
- Save Current Test
- Instrumentation
- Booth Test
- Audiometer Test
- Report
- Certificate
- About

NOTE: The Icon bar may be moved to a different part of the screen by clicking and dragging on its border, moving it to the desired location

Status Bar

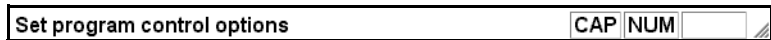


Figure 1-13 *Status Bar*

The status bar displays information on the current pointer function, measurement status, and keyboard such as **CAP** for capital (uppercase) letters or **NUM** for numeric keypad.

After this overview of the AUDit™ software, you are now ready to configure the system before starting new measurements. The next chapter will describe how to setup the software with test database, printer, instrumentation information and other user preferences.

Initial Configuration

Before performing a measurement, a few items need to be configured in the AUDit™ software. This chapter covers setting up a test database, configuring the system printer, entering calibration instrumentation information and other user preferences.

Creating or Selecting a Database

The measurement database is a Microsoft Access compatible file which contains information about your calibration instruments, as well as audiometer and booth test results. During installation, you may have elected to create a blank database (by default Auditdb.mdb in the current directory). If so, you may skip this section.

Hint: You may also use *Ctrl + O* to access the *Change Database* dialog box

To create a new database, click **File, Change Database...** in the AUDit™ menu to open the Change Database dialog box.

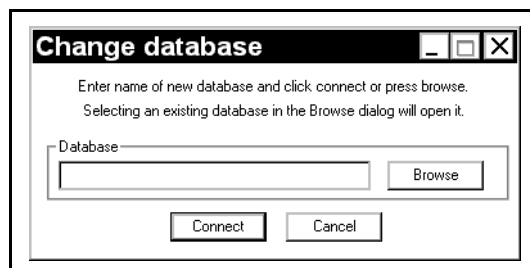


Figure 2-1 *Change database Dialog Box*

If the name of the database in the text box is valid, clicking **Connect** will select it. To use another database or create a new database, click **Browse**.

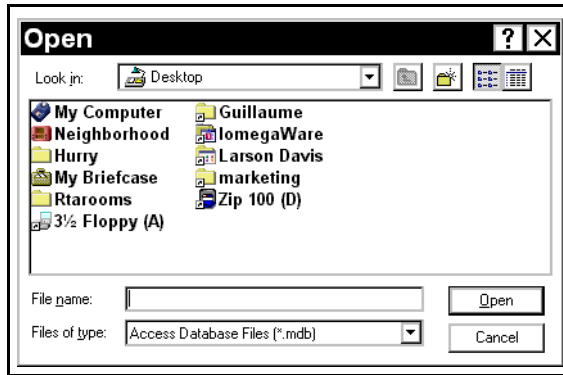


Figure 2-2 *Open Dialog Box*

The Open dialog box will appear, allowing you to select the location of the database. To create a database in a new directory, use the Windows Create Directory icon at the top right of the box. In this example, figure 2-3, we have browsed to the following folder: C:\AUDitData\ by selecting My Computer, C: and creating the AUDit™ Data folder.

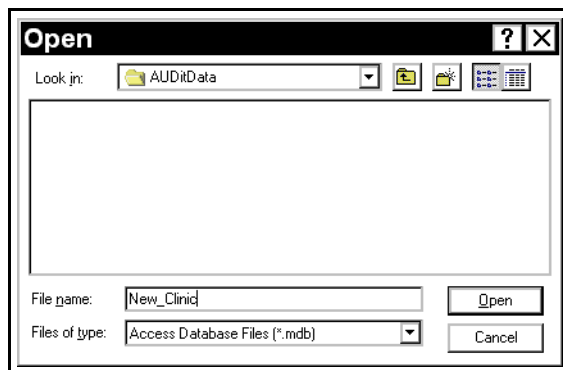


Figure 2-3 *Creating a New Directory*

The name of the database is entered as New_Clinic, and **Open** is clicked. After the message in figure 2-4 is confirmed by clicking **Yes**, the new database is created.

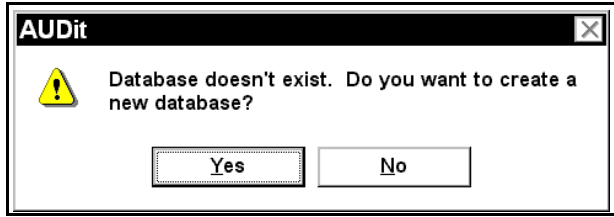


Figure 2-4 *New Database Message*

An existing database is selected in the same fashion. If your system was supplied with a database for your calibration equipment (initial.mdb on the last AUDit™ disk), copy this database to the desired location, rename it, and select it. You may skip the Entering Instrumentation section if you already have an instrumentation database.

Configuring the System Printer

Calibration reports and certificates are an essential output of the AUDit™ software. A Windows printer can be selected for hard copy output. Click **File, Printer Setup...**(figure 2-5)

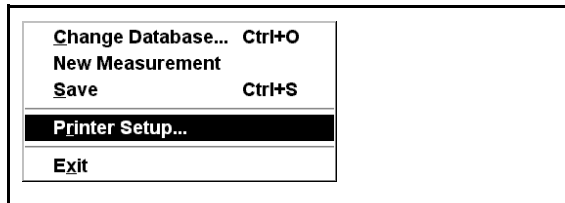


Figure 2-5 *Test, Printer Setup Menu*

to display the Print Setup dialog box, figure 2-6, where the active printer is selected. Printer properties, paper size, source and orientation are set here.

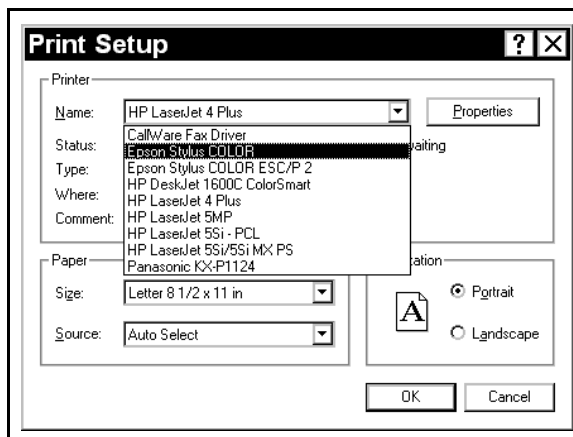


Figure 2-6 *Print Setup Dialog Box*

Refer to your Windows or printer documentation for more information on printer configuration.

Entering Instrumentation

NOTE: *When the desired instrumentation is selected for use with an audiometer measurement, a copy of the instrumentation selected is made and stored with the measurement. If changes are made to a piece of instrumentation, those changes will not be reflected in the copy that is stored with the measurement.*

The AUDit™ audiometer calibration software maintains a list of the instruments used in calibration. These are normally certified traceable to NIST - National Institute of Standards and Technology - measurement standards at specified intervals. All this information is entered in the Instrumentation... Screen, figure 2-8.

Click **Test, Instrumentation** to display the Instrumentation screen.

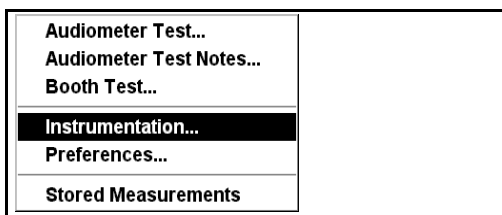


Figure 2-7 *File, Instrumentation Menu*

Instrumentation

Sound Level Meters

Calibrators

Microphones

Mastoids

Preamps

Current Sound Level Meters

Enter available Sound Level Meters

Sound Level Meter

Manufacturer: Larson-Davis

Model: 824

Serial number:

year

month

day

Calibration due:

Add

Update

Delete

Ok

Cancel

Figure 2-8 *Instrumentation Screen*

Note the types of instruments listed in the upper left rectangle: sound level meters, calibrators, microphones, mastoids and preamplifiers. Currently available or defined instruments (in this case, sound level meters) are listed in the rectangle at the lower left. The large area at the right has fields for model, serial number and other information for each type of instrument. If your instrumentation has already been defined for the current database, skip forward to the Setting Preferences section.

Entering Sound Level Meter Information

Currently, the Larson Davis System824 precision sound level meter (SLM) is the only SLM instrument compatible with the AUDit™ software. To enter your SLM information,

click **Test, Instrumentation...** and select **Sound Level Meters** in the upper left box of the screen.

The dialog box is titled "Enter available Sound Level Meters". On the left, under the heading "Instrumentation", there is a list box containing "Sound Level Meters", "Calibrators", "Microphones", "Mastoids", and "Preamps". Below this list is a section labeled "Current Sound Level Meters" with an empty list box. The main area of the dialog is titled "Sound Level Meter" and contains the following fields:

- Manufacturer:
- Model:
- Serial number:
- Calibration due: year, month, day

At the bottom of the dialog are five buttons: "Add", "Update", "Delete", "Ok", and "Cancel".

Hint: Advance from field to field with the Tab key. Typing the first letter of a month will fill in the appropriate month abbreviation in the pull down box.

Figure 2-9 SLM information dialog box

Enter the serial number of your 824 and its calibration due date, both available on labels on the back of the instrument. The calibration date must have four digits within 100 years of the computer's date. Once all fields are completed, click **Add**. A new SLM entry will appear in the lower left box.

- Click **Update** to update the instrument information with new values
- Click **Delete** to remove the instrument entry from the list
- Click **OK** to select the instrument
- Click **Cancel** to terminate data entry without saving the last changes

Entering Calibrator Information

Calibrator information is entered by clicking **Test, Instrumentation...** and selecting **Calibrators** in the upper left box of the screen

The dialog box is titled "Enter available Calibrators". It features a left-hand menu with two sections: "Instrumentation" and "Current Calibrators". Under "Instrumentation", the options are "Sound Level Meters", "Calibrators" (which is selected), "Microphones", "Mastoids", and "Preamps". Under "Current Calibrators", the list shows "CAL250 SN:2702" and "CAL250 SN:4915" (which is selected). The main area of the dialog is titled "Calibrator" and contains several input fields: "Manufacturer:" with the value "Larson-Davis", "Model:" with "CAL250", "Serial Number:" with "4915", "Calibration Due:" with a date picker showing "2002", "Nov", and "13", "Frequency:" with "250.0", and "Output Level:" with "114.0". At the bottom of the dialog are five buttons: "Add", "Update", "Delete", "Ok", and "Cancel".

Figure 2-10 .Calibrator Information Dialog Box

NOTE: The Larson Davis CAL250 calibrator provided with your system has a frequency of 250.0 Hertz and a level of 114.0 dB re 20 micropascals. Output frequency and level will be used by the software in the calibration procedure. Entering incorrect values could lead to measurement errors.

Enter the serial number of your calibrator, its calibration due date, frequency and output level. The calibration date must have four digits within 100 years of the computer's date. Once all fields are completed, click **Add**. A new SLM entry will appear in the lower left box.

- Click **Update** to update the instrument information with new values
- Click **Delete** to remove the instrument entry from the list
- Click **OK** to select the instrument

- Click **Cancel** to terminate data entry without saving the last changes

Entering Microphone Information

Microphone information is entered by clicking **Test, Instrumentation...** and selecting **Microphones** in the upper left box of the screen. Note that this screen has many tabs: Microphone, Low Freq. Response, High Freq. Response, Grid Corrections.

The screenshot shows a software window titled "Enter available Microphones". On the left, there is a sidebar with two sections: "Instrumentation" and "Current Microphones". Under "Instrumentation", a list contains "Sound Level Meters", "Calibrators", "Microphones" (which is highlighted with a black background), "Mastoids", and "Preamps". The "Current Microphones" section is currently empty. The main area of the window has four tabs at the top: "Microphone", "Low Freq. Response", "High Freq. Response", and "Grid Corrections". The "Microphone" tab is active. Inside this tab, there are several input fields: "Manufacturer:" with the text "Larson-Davis", "Model:" with the text "2575", "Serial number:" with the text "1338", "Sensitivity:" with the text "42.42" followed by "mV/Pa", and "Calibration due:" which consists of three sub-fields: "year" with "2001", "month" with a dropdown menu showing "Mar", and "day" with "28". At the bottom of the window, there are five buttons: "Add", "Update", "Delete", "Ok", and "Cancel".

Figure 2-11 *Microphone Information Dialog Box*

Hint: *Microphone frequency response information is available on the calibration chart provided with your microphone. Some audiometric frequencies may not be listed exactly: e.g. 200 Hz is listed as 199.53 Hz. If the frequency labeled in the software is between two frequencies on the certificate, you may wish to enter an interpolated value.*

Enter the serial number of your microphone, its sensitivity and calibration due date in the Microphone tab. The calibration date must have four digits within 100 years of the computer's date. Do not click add until all tabs are completely filled out. Click on the next three tabs to enter microphone frequency response information, figure 2-12.

Enter response values from chart included with microphone	
125	0.03
160	0.02
200	0.01
250	0.00
315	-0.01
400	-0.03
500	-0.04
630	-0.06
750	-0.07
800	-0.08
1000	-0.10
1250	-0.11
1500	-0.12
1600	-0.12
2000	-0.11
2500	-0.07
3000	-0.02
3150	-0.01
4000	0.08
5000	0.06
6000	-0.25
6300	-0.39
8000	-1.65

Figure 2-12 *Microphone Frequency Response Information Dialog Box*

NOTE: *Microphone frequency response information will be used by AUDit™ to correct the sound level retrieved from the SLM at each frequency to obtain the actual sound level.*

Using data provided by the manufacturer or calibration provider, enter the low, high frequency response and grid cap corrections of your microphone.

WARNING!

Data must be entered with a leading zero (i.e. 0.02, not .02) and all frequencies should be entered, do not leave fields blank.

High frequency and grid cap corrections may not be necessary if you are not performing the calibration of extended frequency audiometers.

- Click **Update** to update the microphone information with new values
- Click **Delete** to remove the microphone entry from the list
- Click **OK** to select the microphone
- Click **Cancel** to terminate data entry without saving the last changes

Entering Artificial Mastoid Information

The artificial mastoid is used to calibrate the bone vibrator used for bone conduction audiometry. Information is entered by clicking **Test, Instrumentation...** And selecting **Mastoids** in the upper left box of the screen. Note that this screen has two tabs: Mastoid and Response.

Instrumentation

- Sound Level Meters
- Calibrators
- Microphones
- Mastoids**
- Preamps

Current Mastoids

Enter available Mastoids

Mastoid Response

Manufacturer: Larson-Davis

Model: AMC493

Serial number: 1047

Sensitivity: mV/N

Calibration due: year month day
2001 Mar 12

Add Update Delete Ok Cancel

Figure 2-13 *Mastoids Information Dialog Box*

NOTE: The sensitivity of a B&K mastoid is found on its calibration chart, under the heading *Force Sensitivity* (including cable) and is in units of *mV/N*.

Only two types of mastoids are currently supported by AUDIt™ software: the Larson Davis Model AMC493 and Bruel & Kjaer 4930 artificial mastoids. Therefore, the Manufacturer entry is a pull down menu with those two choices. Enter the manufacturer, model and serial number of your mastoid and its calibration due date. The calibration date must have four digits within 100 years of the computer's date. It is not necessary to enter a sensitivity with the Larson-Davis artificial mastoid.

The artificial mastoid response must be entered, figure 2-14, using data provided by the manufacturer or calibration provider.

Response

NOTE: *Mastoid frequency response information will be used by AUDit™ to correct the voltage level retrieved from the SLM at each frequency to obtain the actual force level produced by the bone vibrator.*

For the Larson-Davis AMC493, enter values listed on the certification document. The Bruel & Kjaer calibration chart typically has three parts. Enter values read from Page 2: Frequency Response at constant dynamic force, using the 5.4 N (black) curve.

WARNING!

Data must be entered with a leading zero (i.e. 0.02, not .02) and all frequencies should be entered. Do not leave blank fields.

Do not click **Add** until all tabs are completely filled out.

Enter available Mastoids	
Mastoid	Response
250	-10.8
315	-11.4
400	-12.0
500	-12.8
630	-13.4
750	-14.1
800	-14.2
1000	-14.4
1250	-14.6
1500	-14.9
1600	-13.8
2000	-12.8
2500	-13.4
3000	-14
3150	-13.3
4000	-12.6
5000	-16.1
6000	-19.9
6300	-21.2
8000	-22.0

Figure 2-14 *Artificial Mastoid Response Entry Dialog Box*

Hint: Advance from field to field with the Tab key.

Hint: Mastoid frequency response information is available on the calibration chart provided with your AMC493. Some audiometric frequencies may not be listed. If the frequency labeled in the software is between two frequencies on the certificate, you may wish to enter an interpolated value.

- Click **Update** to update the mastoid information with new values
- Click **Delete** to remove the mastoid entry from the list
- Click **OK** to select the mastoid
- Click **Cancel** to terminate data entry without saving the last changes

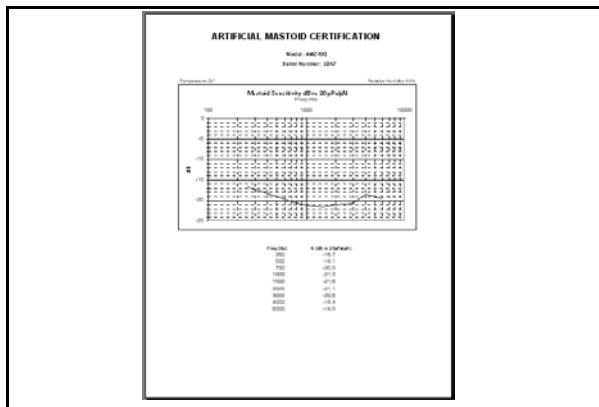


Figure 2-15 *Sample Artificial Mastoid Response chart*

Entering Preamplifier Information

The Larson Davis System824 precision sound level meter (SLM) is supplied with a Model PRM902 preamplifier. To enter your preamplifier information, click **Test, Instrumentation...** And select **Preamps** in the upper left box of the screen.

The screenshot shows a software dialog box titled "Enter available Preamps". On the left side, there is a tree view under the heading "Instrumentation" with the following items: "Sound Level Meters", "Calibrators", "Microphones", "Mastoids", and "Preamps" (which is selected). Below this is a section titled "Current Microphone Preamps" containing a list with two entries: "PRM902 SN-0252" and "PRM902 SN-4388". The main area of the dialog is titled "Preamp" and contains several input fields: "Manufacturer:" with the text "Larson-Davis", "Model:" with the text "PRM902", "Serial number:" with the text "0252", and "Calibration due:" which includes three sub-fields: "year" with "1999", "month" with a dropdown menu showing "Dec", and "day" with "5". At the bottom of the dialog are five buttons: "Add", "Update", "Delete", "Ok", and "Cancel".

Figure 2-16 *Preamplifier Information Dialog Box*

Enter the serial number etched on the barrel of your preamplifier and its calibration due date, which is typically the same as that of the 824. The calibration date must have four digits within 100 years of the computer's date. Once all fields are completed, click **Add**. A new Preamp entry will appear in the lower left box.

Step 1 Click **Update** to update the preamplifier information with new values

- Step 2** Click **Delete** to remove the preamplifier entry from the list
- Step 3** Click **OK** to select the preamplifier
- Step 4** Click **Cancel** to terminate data entry without saving the last changes

Entering Preferences

This configuration item allows the entry of the calibrating organization and selection of communication parameters for the System824 SLM. To enter this information, click Test, Preferences...

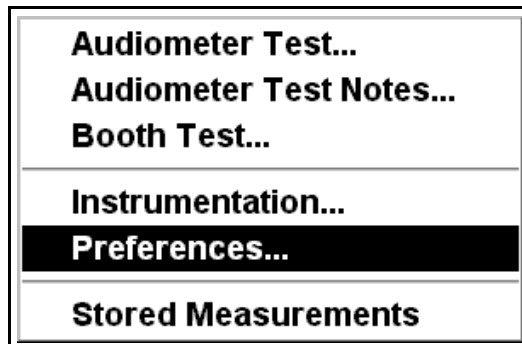


Figure 2-17 *Test, Set Preferences Menu*

to display the Preferences screen. Two system setup items are available in the rectangular area at the upper left of the screen (figure 2-18): Organization and RS232 Port. Click **Organization** to enter information on the organization per-

forming the audiometer calibration such as name, address and telephone number.

The screenshot shows a 'Preferences Dialog Box' with a sidebar on the left titled 'System setup items' containing 'Organization' (highlighted) and 'RS232 Port'. The main area is titled 'Calibration Facility Name' and contains a sub-section 'Calibration Organization'. This sub-section has three text input fields: 'Name' (containing 'Audiometer Calibration & Measurement Experts'), an address field (containing '1234 ACME Boulevard, Suite 5'), and a telephone field (containing 'Anytown, PE 56789-1234 (999)555-1212'). At the bottom right are 'Ok' and 'Cancel' buttons.

Figure 2-18 *Preferences Dialog Box*

This information will appear on the report and calibration certificate. Click **OK** to enter the information in the database.

Click on **RS232 Port** to access the selection screen for RS232 communications port options. Here you may select port number (COM1 to COM8) and RS232 baud rate (300 to

115kBaud) from pulldown menus. Click **OK** to confirm your selection.

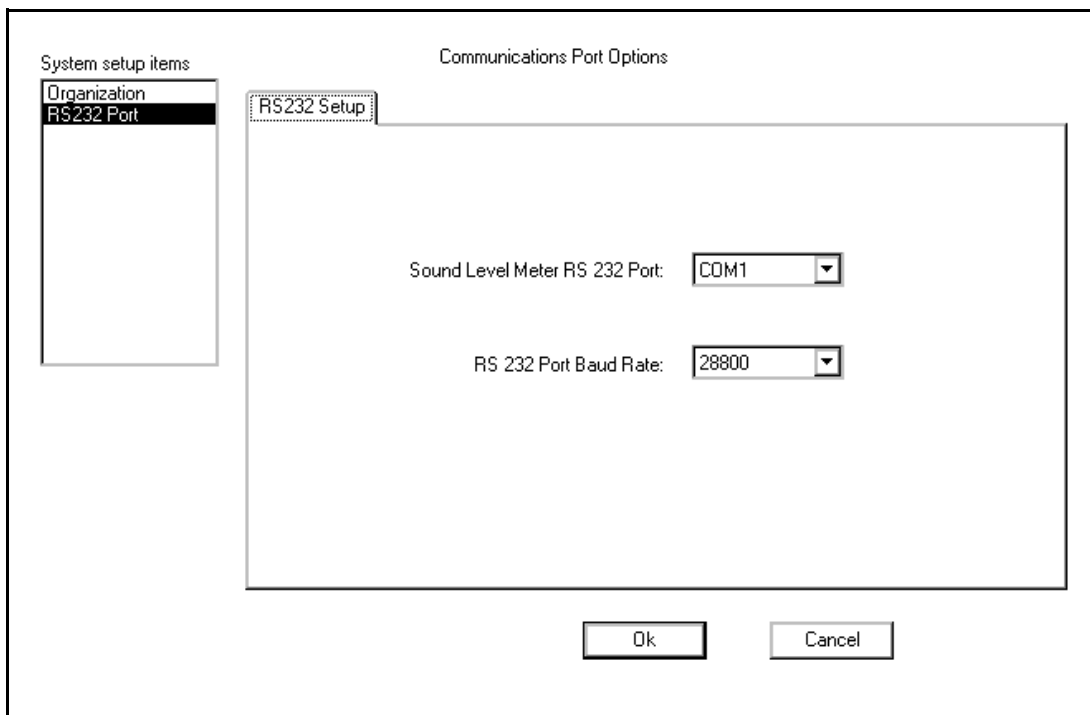


Figure 2-19 *RS-232 Communications Dialog Box*

You have now completed the initial configuration of the AUDit™ software. In the next chapter, the system will be assembled and calibrated to perform an audiometric booth ambient level test.

Audiometer Test Setup

For every audiometer test, the AUDit™ software allows you to fully define the measurement setup as well as the components of the equipment under test. When a measurement is printed or stored, all this information is recorded in your database. Therefore, an audiometer system only needs to be defined once, saving a lot of time in subsequent tests.

In this chapter, you will set up the audiometer test by performing this data entry. You will be able to refer to instruments which were entered previously in the Instrumentation screen. Audiometers and their many sensor types will also be entered.

Audiometer Test Screen

To begin entering test information, click the **Test, Audiometer Test...** drop down menu item. (Figure 3-1)

NOTE: The status line at the bottom of the window shows:

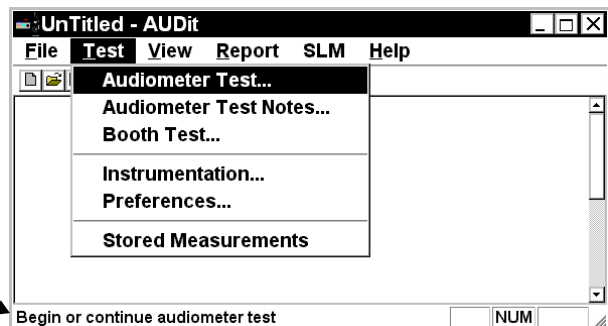


Figure 3-1 *Test Menu*

This will display the Enter Test Location screen (figure 3-2). It is the first of a series of entry screens listed in a column on the left side of the screen. To advance to another screen, use the pointing device to select it from the list:

- Test Location
- Equipment
- Microphones
- Audiometer
- Earphones
- Bone Vibrator
- Speakers

Once data entry is completed, click OK to return to the main AUDit™ screen. Press cancel to end data entry without implementing changes.

Test Location Screen

Setup Items

- Test Location
- Equipment
- Microphones
- Audiometer
- Earphones
- Bone Vibrator
- Speakers

Enter Test Location

Location

Customer Name:

John Wilkes

Location:

New Clinic

1 Clinic Circle, Anytown, PE 09876

Ok Cancel

Figure 3-2 *Test Location Dialog Box*

This is where customer information is entered.

The Test Location screen (figure 3-2) contains the following fields:

- Customer Name: one line for the customer or company name
- Location: two lines for the location of the audiometer, telephone number or other text data you wish to save.

Select Test Equipment Screen

NOTE: When the desired instrumentation is selected for use with an audiometer measurement, a copy of the instrumentation selected is made and stored with the measurement. If changes are made to a piece of instrumentation, those changes will not be reflected in the copy that is stored with the measurement.

This screen is one of the multiple tab screens you will find in AUDit™. The equipment used to test the audiometer is selected here from the instrumentation which was entered earlier.

The Test Location screen is composed of four tabs (Figures 3-3 to 3-6).

SLM Tab

Setup Items

- Test Location
- Equipment**
- Microphones
- Audiometer
- Earphones
- Bone Vibrator
- Speakers

Select Test Equipment

Sound Level Meter | Calibrator | Mastoid | Preamp

Serial Number: 0251

Model: 824

Manufacturer: Larson-Davis

Calibration Due: 1999-12-05

Ok Cancel

Figure 3-3 *Sound Level Meter Selection Tab*

The SLM selection Tab (figure 3-3) screen contains the following fields:

Serial number, Model, Manufacturer, Calibration Due. Only the first field is selectable from a drop down list of the previously entered sound level meters.

Calibrator Tab

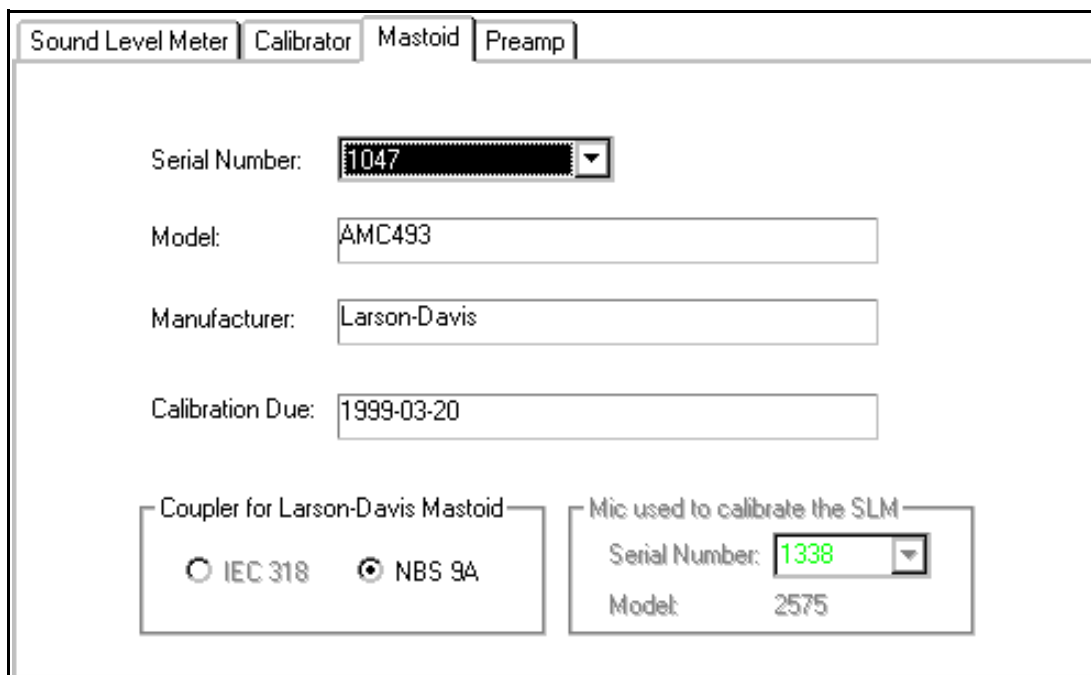
Sound Level Meter	Calibrator	Mastoid	Preamp
Serial Number:	2702		
Model:	CAL250		
Manufacturer:	Larson-Davis		
Frequency:	250.0	Level:	114.0 dB
Calibration Due:	2001-02-18		

Figure 3-4 *Calibrator Selection Tab*

The Calibrator selection tab (figure 3-4) contains the following fields:

Serial number, Model, Manufacturer, Frequency, Level, Calibration Due. Only the first field is selectable from a drop down list of previously entered calibrators.

Mastoid Tab



Sound Level Meter Calibrator **Mastoid** Preamp

Serial Number: 1047

Model: AMC493

Manufacturer: Larson-Davis

Calibration Due: 1999-03-20

Coupler for Larson-Davis Mastoid

☐ IEC 318 ☒ NBS 9A

Mic used to calibrate the SLM

Serial Number: 1338

Model: 2575

Figure 3-5 *Mastoid Selection Tab*

The Mastoid selection tab (figure 3-5) contains the following fields:

Serial number, Model, Manufacturer, Calibration Due, Coupler for Larson-Davis Mastoid, Mic used to calibrate the SLM.

The first field is selectable from a drop down list of the previously entered serial numbers, which determines the Model and Manufacturer. The Larson-Davis AMC493 and B&K 4930 artificial mastoids are supported by AUDit™. The two boxes at the bottom of the screen are active only for the appropriate mastoid.

Coupler for Larson-Davis Mastoid

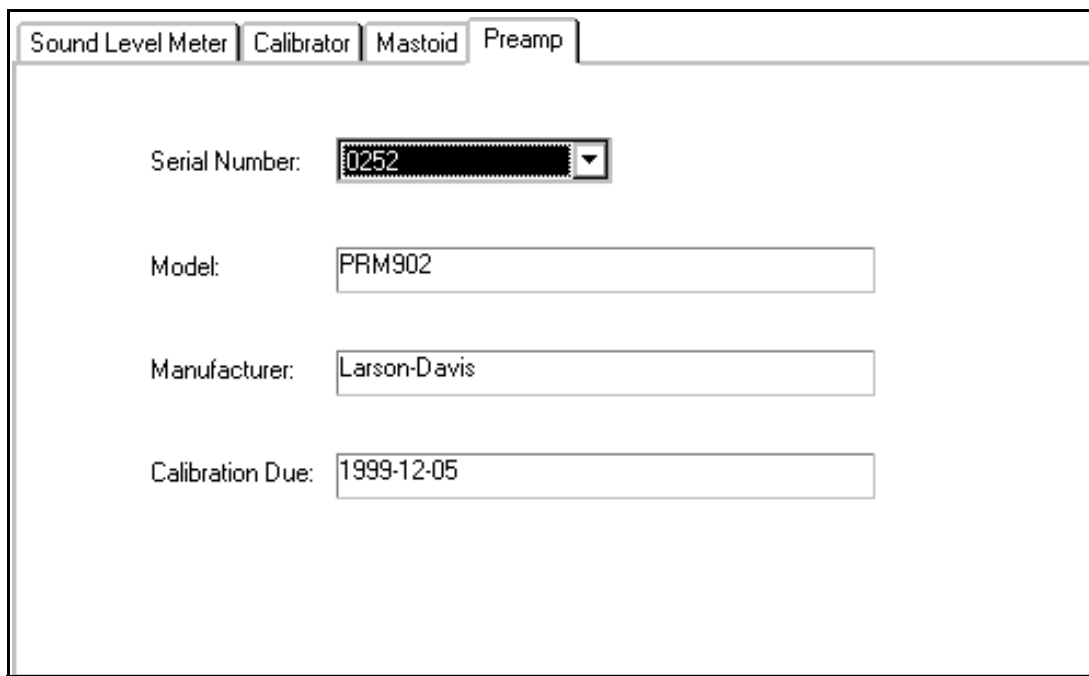
NOTE: *Calibration data is currently only available for the AEC100 coupler.*

Since the Larson-Davis AMC493 artificial mastoid requires corrections based on the coupler with which it is used this radio button selects either the IEC 318 (Larson-Davis Model AEC101) or the NBS 9A (Larson-Davis Model AEC100) coupler.

Mic used to calibrate the SLM

This box is only enabled with the Bruel & Kjaer artificial mastoid. It is used to specify which microphone will be used to calibrate the SLM before using the mastoid. Mastoid and microphone sensitivities are used to calculate the output level of the bone vibrator.

Preamp Tab



The screenshot shows a software window with four tabs: "Sound Level Meter", "Calibrator", "Mastoid", and "Preamp". The "Preamp" tab is currently selected. Below the tabs, there are four input fields:

- Serial Number:** A dropdown menu showing "0252" with a small downward arrow on the right.
- Model:** A text box containing "PRM902".
- Manufacturer:** A text box containing "Larson-Davis".
- Calibration Due:** A text box containing "1999-12-05".

Figure 3-6 *Preamplifier Selection Tab*

The Preamp selection tab (figure 3-6) contains the following fields:

Serial number, Model, Manufacturer, Calibration Due. Only the first field is selectable from a drop down list of the previously entered preamplifiers.

Select Microphones Screen

Setup Items

- Test Location
- Equipment
- Microphones**
- Audiometer
- Earphones
- Bone Vibrator
- Speakers

Select Microphones

IEC 318 Mic | NBS 9A Mic | IEC 711 Mic | HA-1 Mic | HA-2 Mic | Open Air Mic

Serial Number: 1338
1338
1441

Model: 2575

Manufacturer: Larson-Davis

Calibration Due: 2001-03-28

Ok Cancel

Figure 3-7 *Select Microphone Dialog Box*

The Select Microphones screen (figure 3-7) is a multiple tab screen. It allows you to select the microphone paired with each of the couplers used in the test setup for various audiometric transducers. There are six different tabs, all of which have the same format. Each microphone tab contains the following fields:

Serial number, Model, Manufacturer, Calibration Due. Only the first field is selectable from a drop down list of previously entered microphones. If a specific coupler will not be used in the audiometer calibration, you do not need to enter it. The various tabs are:

IEC 318 Mic Tab

Select the microphone used with the IEC 60318 coupler. This coupler is designed in accordance with International *Electrotechnical Commission (IEC) standard IEC 60318-1 (1998-07): Electroacoustics - Simulators of human head and ear - Part 1*: Ear simulator for the calibration of supra-aural earphones. It presents a known acoustical impedance to the test earphone. When used with adapters defined in the same family of standards, the IEC 318 coupler can also calibrate supra-aural earphones in an extended frequency range. The Larson Davis AEC101 artificial ear is designed to meet these standards.

NBS 9A Mic Tab

Select the microphone used with the NBS 9A coupler. This coupler was originally developed by the National Bureau of Standards, now called the National Institute of Standards and Technology (NIST). It is specified in American National Standard Institute *Specifications for Audiometers, S3.6-1996 for calibrating earphones used in audiometry*. The Larson Davis AEC100 artificial ear is designed to meet this standard.

IEC 711 Mic Tab

Select the microphone used with the IEC 60711 coupler. This coupler is described in *IEC 60711 (1981-01) Occluded-ear simulator for the measurement of earphones coupled to the ear by ear inserts*. The standard specifies an occluded-ear simulator for the calibration of insert earphones from 100 Hz to 10 kHz.

HA-1 Mic Tab

Select the microphone used with the HA-1 coupler. This coupler is described in *IEC 60126 (1973-01) IEC reference coupler for the measurement of hearing aids using earphones coupled to the ear by means of ear inserts*. The cou-

pler is designed to load the earphone with a specified acoustic impedance when determining the performance of air-conduction hearing aids using earphones coupled to the ear from 200 Hz to 5kHz.

HA-2 Mic Tab

Select the microphone used with the HA-2 coupler. This coupler is also described in *IEC 60126 (1973-01) IEC reference coupler for the measurement of hearing aids using earphones coupled to the ear by means of ear inserts*. The coupler is useful in determining the performance of insert earphones with a nub or molded ear insert. It may also be used to qualify earphones which use a tube to connect to an ear mold or insert.

Open Air Mic Tab

Select the microphone used for open air measurements such as the ambient noise level measurement of the Booth Test, or speakers tests.

Audiometer Description Screen

Setup Items

- Test Location
- Equipment
- Microphones
- Audiometer**
- Earphones
- Bone Vibrator
- Speakers

Audiometer Description

Audiometers | Low Frequencies | High Frequencies

Manufacturer: Interacoustics

Model: AD226 Audiometer Type: 4

Serial Number: 004 005 97 Inventory Number: MK23984

Date last calibrated: year: 1998 month: Aug day: 30 Number of Channels: 2

Calibration due date: year: 1999 month: Aug day: 30 Channel to test: 1

FM tone modulated at 5 % of carrier frequency at a rate of 5 Hz.

Ok Cancel

Figure 3-8 *Audiometer Description Screen*

The Audiometer Description screen is a multiple tab screen. It contains information on the audiometer (or signal generator) under test, while its transducers are defined in the remaining screens of the setup items. The Audiometer Description screen is composed of three different tabs to describe the audiometer and its tested output frequencies.

Audiometers Tab

The Audiometers Tab contains the following fields:

- Model, Manufacturer, Serial number, Audiometer Type, Inventory Number, Date last calibrated, Calibration due date, Number of Channels, Channel to test, FM tone modulated at ____% of carrier frequency at a rate of ____ Hz. Some details on the entries follow.

NOTE: *American National Standard S3.6-1996 Specifications for Audiometers specifies the designation of audiometers satisfying the standard. The minimum required facilities for each designation are listed in table 1 of the standard.*

NOTE: *ANSI S3.6-1996 pure tone Type 1 and 2 audiometers must have a facility for presenting a frequency modulated tone.*

- **Audiometer Type:** Enter this descriptive pure tone audiometer type number, which should be stated in the audiometer specifications or labeled on the instrument itself. Additional suffixes for high frequency, speech or free field equivalent are not available but may be entered in the Audiometer Test Notes... comments.
- **Number of Channels:** Enter the number of channels if the tested audiometer has multiple channels. Drop down menu selections are 1 and 2.
- **Channel to test:** Enter the channel which will be tested. Depending on the number of channels, you may select 1 or 2 in the drop down menu.
- **FM tone modulated...:** Enter the audiometer's frequency modulation percentage and rate of modulation. These values will be verified in the appropriate test.

Low Frequencies Tab

The Low Frequencies tab allows you to specify which audiometer frequencies will be tested. It contains a list of audiometer frequencies from 125 to 8000 Hz. Each frequency may be selected by clicking on the box to its left. Click again to deselect a frequency. The Set to Default Frequencies button selects only the common frequencies: 125, 250, 500, 750, 1000, 1500, 2000, 3000, 4000, 6000, and 8000 Hz. Additional frequencies may be added after setting the default frequencies.

High Frequencies Tab

The High Frequencies tab allows you to specify which high frequencies available on the audiometer will be tested. These frequencies are used by extended high frequency pure tone audiometers (ANSI S3.6-1996 Type xHF designation). Each frequency may be selected by clicking on the box to its left. Click again to deselect a frequency.

Select Earphones Screen

The Select Earphones screen (figure 3-9) is composed of three different tabs, one each for supra-aural, insert, and circumaural earphones. Each tab lets you enter the audiometer earphones and the respective artificial ear couplers used in the test setup. If a certain type of earphone is not used, it does not need to be defined.

The screenshot shows a software window titled "Select Earphones". On the left is a "Setup Items" sidebar with a list: "Test Location", "Equipment", "Microphones", "Audiometer", "Earphones" (highlighted), "Bone Vibrator", and "Speakers". The main area has three tabs: "Supra-aural", "Insert", and "Circumaural", with "Supra-aural" selected. The form contains the following fields: "Model:" with a dropdown menu showing "TDH 50"; "Manufacturer:" with a text box containing "Telephonics"; "Right Serial Number:" with a text box containing "C 28280"; "Left Serial Number:" with a text box containing "C 28281"; and "Coupler" with two radio buttons, "IEC 318" and "NBS 9A", where "NBS 9A" is selected. At the bottom right are "Ok" and "Cancel" buttons.

Figure 3-9 *Select Earphones screen, showing supra-aural tab.*

Supra-aural Tab

The Supra-aural Tab contains the following fields:

Model, Manufacturer, Right Serial number, Left Serial number, Coupler.

The Model entry is a drop down menu with the following choices: TDH 39, TDH 49 and TDH 50. The Manufacturer field is set as Telephonics. The Coupler field has two radio buttons with a value of IEC 318 or NBS 9A. NBS 9A is the default setting.

Insert Tab

The screenshot shows a software window with three tabs: 'Supra-aural', 'Insert', and 'Circumaural'. The 'Insert' tab is selected. Inside the tab, there are four input fields: 'Model' is a dropdown menu showing 'ER-3A'; 'Manufacturer' is a text box containing 'Etymotic'; 'Right Serial Number' is a text box containing 'A 1234'; and 'Left Serial Number' is a text box containing 'A 1235'. Below these fields is a 'Coupler' section with three radio buttons: 'EC 711' (which is selected), 'HA - 1', and 'HA - 2'.

Figure 3-10 *Insert Earphone Tab*

The Insert tab (Figure 3-10) contains the following fields:

Model, Manufacturer, Right Serial number, Left Serial number, Coupler.

The Model entry is a drop down menu with the following choices: ER-3A and 3A. The Manufacturer field defaults to Etymotic for the ER-3A and EARTone for the 3A model. The Coupler field has three radio buttons with a value of IEC 711, HA-1 or HA-2.

Circumaural Tab

The screenshot shows a software window with three tabs: 'Supra-aural', 'Insert', and 'Circumaural'. The 'Circumaural' tab is selected. Inside the tab, there are several input fields: 'Model' is a dropdown menu with 'HV/1A' selected and a list showing 'HDA200' and 'HV/1A'; 'Manufacturer' is a text field with 'Koss' entered; 'Right Serial Number' and 'Left Serial Number' are empty text fields; and 'Coupler' is a dropdown menu with 'IEC 318 only' selected.

Figure 3-11 *Circumaural Earphone Tab*

NOTE: *AUDit™ uses the supra-aural earphone reference equivalent threshold sound pressure levels (RETSPLs) in dB re 20 micropascals for common earphones listed in Table 6 of ANSI S3.6-1996. The RESPLs referred to the appropriate coupler are used in the calibration process. In the case of insert earphones, The RETSPLs listed in Table 7 of ANSI S3.6-1996 are used. Circumaural earphones interim RETSPLs listed in Table C1 are used by AUDit™. Contact Larson-Davis for information on enabling additional earphones with the manufacturer's valid RETSPL data.*

The Circumaural tab (Figure 3-11) contains the following fields:

Model, Manufacturer, Right Serial number, Left Serial number, Coupler.

The Model entry is a drop down menu with the following choices: HDA200 and HV/1A. The Manufacturer field defaults to Sennheiser for the HDA200 and Koss for the Model HV/1A. The Coupler field defaults to IEC 318 only.

Bone Vibrator

Setup Items

- Test Location
- Equipment
- Microphones
- Audiometer
- Earphones
- Bone Vibrator**
- Speakers

Bone Vibrator Description

Bone Vibrator

Manufacturer: Radiophone

Model: B-71

Serial number: AUD1A

Ok Cancel

Figure 3-12 *Bone Vibrator Description Screen*

The Bone Vibrator Description screen (Figure 3-12) contains the following entry fields: Manufacturer, Model, and Serial Number. Enter the appropriate information for the vibrator in use with the calibrated audiometer.

Speakers

Setup Items

- Test Location
- Equipment
- Microphones
- Audiometer
- Earphones
- Bone Vibrator
- Speakers**

Speaker Description

Left Speaker Right Speaker

Manufacturer: DBOX

Model: DB25

Serial number: 0255

Ok Cancel

Figure 3-13 *Speaker Description Screen*

The Speaker Description screen (Figure 3-12) contains two tabs, Left and Right, each with the following entry fields: Manufacturer, Model, and Serial Number. Enter the appropriate information for the speakers in use with the calibrated audiometer.

Booth Test or Ambient Noise Level Test

You have now configured the AUDit™ software in preparation for your first test. In this chapter, the system will be calibrated to perform a measurement of ambient levels in the audiometric test room. This is referred to as a booth test in the AUDit™ software. In doing this test, we will also cover connecting to the SLM and calibrating it.

If ambient noise levels in an audiometric test room are excessively high, they can have a masking effect on the subject, effectively raising the measured hearing threshold. This is most likely to occur if very low hearing threshold levels are being measured.

NOTE: This and the other ANSI standards mentioned in this manual are available from the Acoustical Society of America, 120 Wall St., 32nd Floor, New York, NY, 10005-3993, (212)248-0373.

AUDit™ allows simultaneous assessment of noise levels for audiometric measurements with ears covered or not covered, in the frequency ranges of 125, 250 and 500 Hz to 8000 Hz. This test and its pass/fail limits are based on the recommendations of American National Standard on *Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms, ANSI S3.1 - 1991 (ASA 99-1991)*.

In order to consider the worst case conditions for an audiometric test, the ambient noise test should be performed with all possible noise sources present. If certain sources are operating at certain times but not at others, it may be necessary to schedule the measurement accordingly.

Assembling the system

The Larson Davis System824 precision sound level meter meets all the requirements of the aforementioned standard for the measurement of ambient noise level in the audiometric test room. Its low self-noise and internal fractional octave band measurement capability enable it to accurately measure octave and third octave levels much below the minimum required levels, when using a high sensitivity microphone such as the Larson Davis model 2575 or 2570.

Equipment for Booth Test

The equipment listed below is suggested for ambient noise testing with AUDit™.

- PC with AUDit™
- CBL006 serial cable
- System824 precision sound level meter
- EXC010 extension cable (optional)
- PRM902 preamplifier
- 2575 microphone
- ADP008 1/2 inch preamp to 1 inch microphone thread adaptor
- CAL250 precision Sound Pressure Level calibrator

NOTE: The microphone/preamp assembly may be suspended or supported with a suitable microphone clamp. If the dimensions or construction of the audiometric test room require a longer length of cable or the use of patch panels, care must be taken not to introduce ground loops or other problems which can lead to higher system self-noise levels.

Assembling the system

- Step 1** Connect the CBL006 from the SERIAL connector on the butt plate of the 824 SLM to the active serial port on the computer



Figure 4-1 *Connecting CBL006 to 824*

- Step 2** Install the PRM902 microphone preamplifier directly on the SLM or use the EXC010 extension cable by matching red dots on opposite gender connectors



Figure 4-2 *Connecting EXA010 extension cable to 824 and PRM902*

- Step 3** Thread the ADP008 onto the PRM902 preamplifier, being careful not to strip the threads

Step 4 Thread the 2575 or other microphone onto the PRM902 preamplifier, being careful not to strip the threads



Figure 4-3 *Connecting PRM902, ADP008 and 2575 Microphone*

Connecting to the SLM

If AUDit™ is not active, run the software by clicking **Start, Programs, Larson Davis Programs, AUDit™** (if AUDit™ was installed in the default folder). Verify communications port options in the Test, Preferences..., RS232 Port tab. The System824 should have the same settings.

*NOTE: The Communications settings on the System824 are accessed by pressing , scrolling to **Communications**, and pressing the  key. Please refer to the 824 reference manual (I824.01) for complete instructions.*

Click **SLM, Connect**



Figure 4-4 *Connect Menu*

to establish connection with the SLM. You may verify battery level by clicking **SLM, Check Battery...** (Figure 4-4)

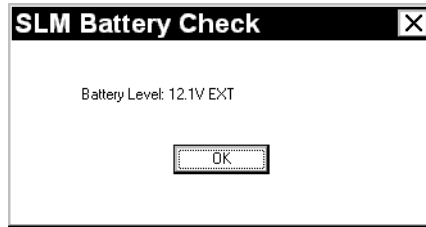


Figure 4-5 *Battery Check Window*

In this case the battery voltage is 12.1 Volts (figure 4-5), with external power. Internal battery status is reported in percent. Measurements should not be attempted with internal battery readings lower than 10%.

System SPL Calibration

NOTE: Calibrator and microphone must be selected as shown in the next section before calibration check or change

The reference level of the sound level meter is calibrated with the use of the CAL250 or another precision calibrator. This instrument generates a known sound pressure level (SPL) relative to 20 micropascals. To calibrate, click **SLM, Calibration...**

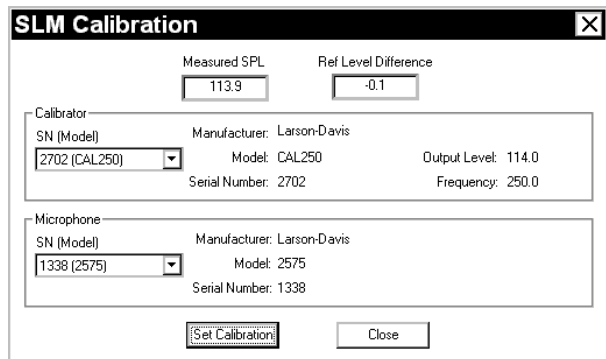


Figure 4-6 *SLM Calibration Window*

Hint: *Do not hold or bump the calibrator during calibration. Vibrations may affect readings. All measurement system components should have reached a stable temperature before calibrating. Your calibrator should remain on for the duration of the calibration (about 30 seconds). If its battery is low, replace it to extend the tone duration.*

AUDit™ will display the SLM Calibration dialog box. Select your calibrator and microphone in the pull down menus. Note that the current level and the difference between it and the calibrator output level are displayed at the top of the box.(Figure 4-6) You may use this display to check calibration without changing it, then click on Close to exit. To change calibration click **Set Calibration**.

A prompt will ask you to turn on your calibrator. The System824 must be calibrated in two ranges, with a stabilization period between both calibrations. Please follow the prompts.

Performing the Booth Test

Once the SLM has been calibrated, the ambient noise levels can be measured. Select the **Test, Booth Test** menu item to display the Booth Ambient Levels Measurement screen.

Booth Ambient Levels Measurement

Location | SL Meter | Preamp | Mic | Calibrator | 125 - 8K Hz | 250 - 8K Hz | 500 - 8K Hz

Booth:
Quiet Tech Number 1

Customer Name:

Location:
New Clinic
1 Clinic Circle, Anytown, PE 19874

Measurement Date:
4/5/99 2:13:16 PM

Measure All | Ok | Cancel

Figure 4-7 *Measurement Location screen*

A number of tabs are displayed (figure 4-7), as follows:

Location	Contains text fields for Booth, Customer Name, and Location of the room getting measured. Enter the appropriate values.
SL Meter, Preamp, Mic tabs	The next three tabs contain the Serial Number, Model, Manufacturer, and Calibration Due date fields of SL Meter, Preamp, and Mic instruments previously entered in the database. Select the appropriate instrument from the pulldown menu.

Booth Ambient Levels Measurement

Location	SL Meter	Preamp	Mic	Calibrator	125 - 8K Hz	250 - 8K Hz	500 - 8K Hz
----------	----------	--------	-----	------------	-------------	-------------	-------------

Serial Number:

Model:

Manufacturer:

Calibration Due:

Measure All

Ok

Cancel

Figure 4-8 *SLM selection and Information Window.*
(Preamplifier and Microphone windows are similar.)

Calibrator Tab

The screenshot shows a software window titled "Booth Ambient Levels Measurement". At the top, there is a row of tabs: "Location", "SL Meter", "Preamp", "Mic", "Calibrator", "125 - 8K Hz", "250 - 8K Hz", and "500 - 8K Hz". The "Calibrator" tab is currently selected. Below the tabs, the window contains several input fields and buttons. The "Serial Number:" field is a dropdown menu showing "2702". The "Model:" field is a text box containing "CAL250". The "Manufacturer:" field is a text box containing "Larson-Davis". The "Frequency:" field is a text box containing "250.0". The "Level:" field is a text box containing "114.0", followed by "dB". The "Calibration Due:" field is a text box containing "2001-02-18". At the bottom of the window, there are three buttons: "Measure All", "Ok", and "Cancel".

Figure 4-9 *Calibrator selection and Information Window*

The Calibrator tab (figure 4-9) contains the same fields as "SL Meter" as well as the frequency and the output SPL of the calibrator selected from the pull down menu.

NOTE: A message (Figure 4-10) will be displayed while the measurement is performed.

After selecting the equipment used for the ambient test, click **Measure All** to begin the test.

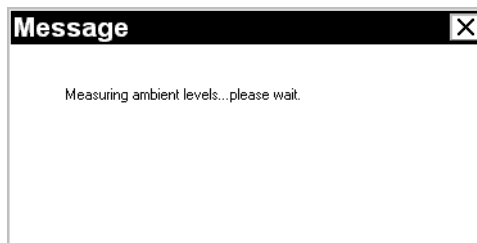


Figure 4-10 *Ambient Level Test Message Window*

**125 - 8K Hz, 250 - 8K Hz, and
500 - 8K Hz Tabs**

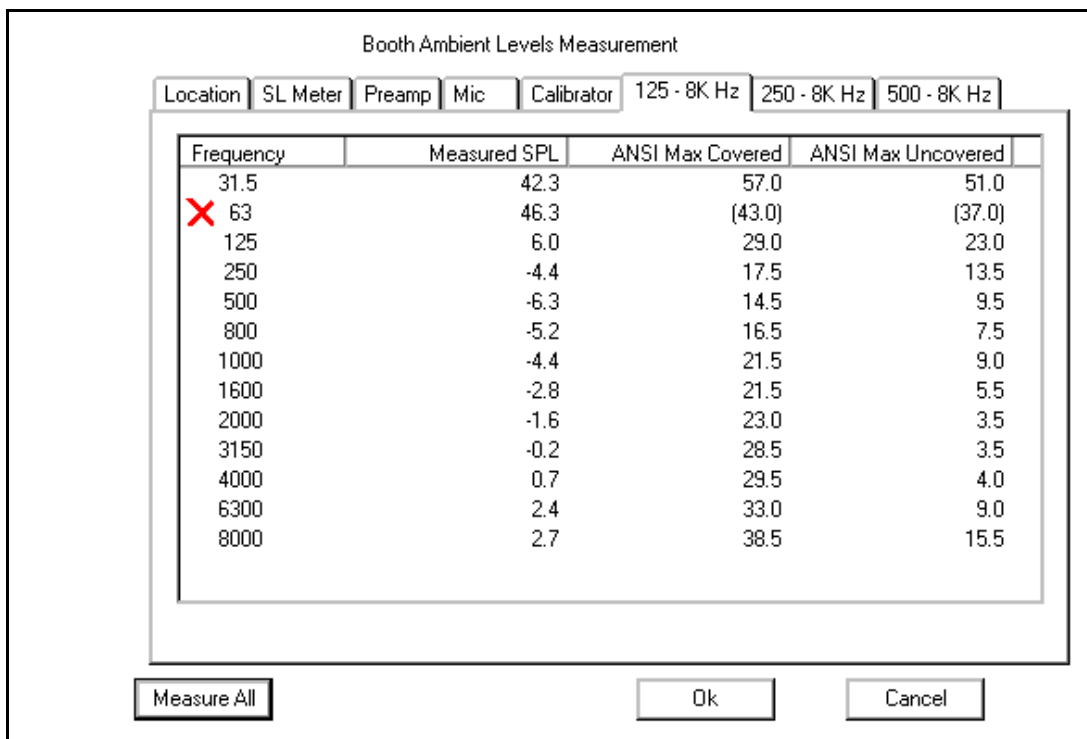


Figure 4-11 *Ambient Level 125-8kHz Results Window*

NOTE: The limits used in these tabs are from Tables III and B2 of the American National Standard on Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms ANSI S3.1 - 1991 (ASA 99-1991). The limits for the third octave bands centered at 31.5 and 63 Hz are interim values derived from the assumption that masking from lower frequency noise affects audiometric measurements at 125 Hz and above.

Once the measurement is completed, these three tabs show Booth Test results. (Figure 4-11) Failed frequencies are indicated with a red mark. In this case, the failed 63 Hz third octave measured SPL was 46.3 dB SPL, whereas the standard allows at most 43.0 and 37.0 dB for covered and not covered ears. The exceeded limit values are displayed between parentheses. Since the limits of the 125 - 8K Hz test are the most stringent, if no failure exists on this tab, the others tabs will also show no failure.

Saving the Booth Test

Once the test is complete, you may save it by clicking **OK** at the bottom of the Booth Ambient Levels Measurement screen, which will display the dialog box shown in figure 4-12:

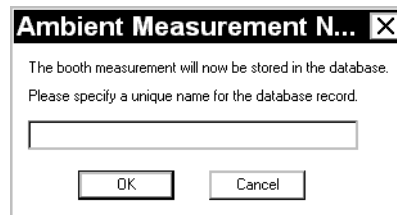


Figure 4-12 *Ambient Level Test Save Window*

where you can enter a descriptive string which will be used to index this record in the measurement database. To search previous booth tests, refer to the chapter on Stored Measurements.

Suspecting Instrument Noise?

Should the readings of the ambient test be questionable, you may want to check the measurement system noise. There are a few ways to do this. One simple alternative is to repeat the measurement with the non-functioning calibrator left on top of the microphone. Another would be to do the booth test without a bias voltage on the microphone. This has the effect of reducing its sensitivity and will show the electrical noise of the system. The results of this second method are shown in figure 4-13.

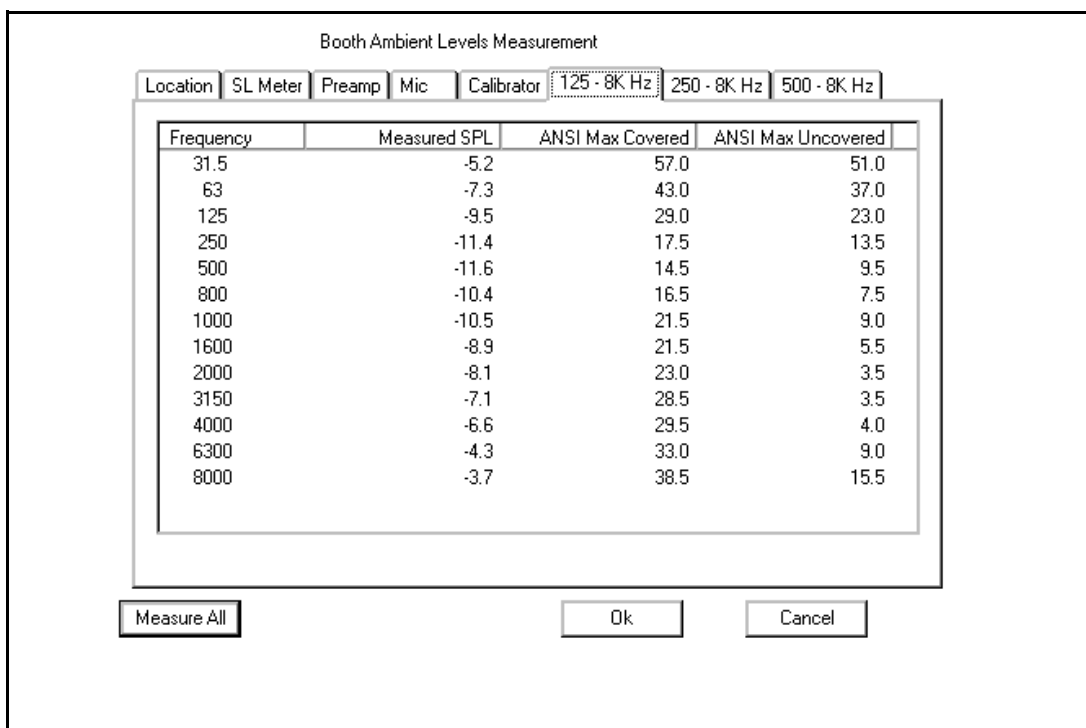


Figure 4-13 *Booth Ambient Levels Window*

As you can see, the noise level at the third octave centered at 63 Hz is -7.3 dB SPL, well below the failing ambient level. This would indicate that the noise was not produced in the instrumentation.

Hint: To remove the bias voltage from the microphone, stop the 824 and press **⌘ (Setup)**, **➡ (Right Arrow)** to modify the Audtest.AUD settings. Scroll to SLM, press **➡ (Right Arrow)** and scroll down to modify SLM parameter Transducer. Press the **⌘ (Check key)** and perform an Overall Reset to select Elcrt. **DO NOT FORGET TO RESET THE TRANSDUCER TO Condnsr BEFORE MAKING NEW MEASUREMENTS.**

This measurement has demonstrated the ease of use of the Larson Davis audiometer calibration system. In the remainder of this manual, a full audiometer calibration will be performed.

5

Assembly of the Audiometer Test System

NOTE: You must use the setup defined for each transducer earlier in the AUDit™ software as described in the Audiometer Test Setup chapter. This will ensure the proper microphone corrections, RETSPL's etc. are applied to the measurement.

This chapter covers test configurations for the audiometer transducers which can be calibrated by the LD audiometer calibration systems. The recommended configurations for various earphones will be described first. Common elements such as the PC to System 824 SLM and PRM902 preamplifier connections, inspection and calibration procedures are explained next. Please contact Larson Davis if you have any system assembly questions not covered in this manual.



Audiometer Transducer Test Configurations

The table below lists some typical audiometer transducers, many of which are covered in specifications such as *American National Standards Institute Specifications for Audiometers, S3.6-1996*. When configuring the audiometer transducer test, the AUDit™ software suggests or defaults to appropriate setups. These test setups are covered in greater detail in subsequent sections.

Transducer Type	Example	Suggested Setup	Comments
Supra-aural earphone	Telephonics TDH-39, 49, 50	AEC100 NBS 9-A coupler or AEC101 IEC 318 artificial ear	Use 4-5 N weight. Test up to 8000 Hz.
Circumaural earphone	Sennheiser HDA200	AEC101 IEC 318 artificial ear with MAEC101.06 Type 1 adaptor plate	Use 9-10N weight. Extended frequency tests up to 16000 Hz may be performed.
Circumaural earphone	Koss HV/1A	AEC101 IEC 318 artificial ear with MAEC101.07 Type 2 adaptor plate	Use 9-10N weight. Extended frequency tests up to 16000 Hz may be performed.
Bone vibrator	Radiophone B-71	AEC100 NBS 9-A coupler and AMC493 artificial mastoid	Use 9-10N weight
Speakers	Speakers	Use ambient noise level test setup from Chapter 4.	
Insert earphone	Insert Earphone	2.0 cm ³ or Type 2 coupler	Refer to earphone and coupler manufacturer information.

Connecting the PC, 824 and PRM902 Preamplifier

WARNING! Before continuing, ensure that the 824 SLM is turned off. Sensitive circuitry may be adversely affected by transients during assembly if the 824 is on. The 824 should remain off until the system is fully assembled.

- Step 1** Connect the CBL006 RS-232 cable from the SERIAL connector on the butt plate of the 824 to the active RS-232 port on the computer (figure 5-1).



Figure 5-1 *Connecting CBL006 to 824*

- Step 2** Connect the male end of the EXA010 extension cable to the nose cone of the 824 by matching the red dots on mating connectors (figure 5-2).



Figure 5-2 *EXA010 extension cable approaching System 824.*

- Step 3** After the PRM902 microphone preamplifier has been inserted in the appropriate coupler, (see below) connect it to the nose cone of the 824 with the EXA010 extension cable by matching the red dots on mating connectors (figure 5-3).



Figure 5-3 *Preamp connecting to extension cable and to AEC100.*

- Step 4** The 824 SLM may now be turned on to select RS-232 parameters. Press the  key on the 824.
- Step 5** Press , scroll down with the  to **Communication** and press  to edit **Serial Comm.** parameters. Set the parameters as desired. 9600 Baud, serial address 000 and Hdw'r flow control are suggested.

AEC100 NBS 9-A Coupler Initial Inspection and Assembly

For this you will need:

Part Number	Description
AUDit™	AUDit™ software running on a PC
CBL006 serial cable	Serial cable 8 pin mini DIN to DB-9
824	System824 precision sound level meter (SLM)
EXA010	10 foot extension cable with 7 pin LEMO connectors
2575	1" precision air condenser microphone
PRM902	1/2" diameter low noise microphone preamplifier
CAL250	Precision SPL calibrator with 114 dB SPL output at 250 Hz
The following are AEC100 components:	
MAE100.1	6 cc coupler
MAE100.3	1 inch coupler cap
SP-MAE100.40	Artificial ear base
MAE100.6	Earphone retainer ring
MAEC100.7	Mass handle
SAEC100.01	Weight assembly
ACC001	Vibration isolation pad

WARNING! Before continuing, ensure that the 824 SLM is turned off. Sensitive circuitry may be adversely affected by transients during assembly if the 824 is on. The 824 should remain off until the system is fully assembled.

The AEC100 artificial ear is an elegant, compact precision coupler built to provide a lifetime of dependable use with reasonable care. Read the following instructions to unpack, inspect and assemble the coupler for the first time.

Step 1 Place the cushioned vibration isolation pad on a table or other such stable surface near the audiometer system.

Step 2 Visually inspect the coupler (MAE100.1) for gouges, scratches and dents which may affect the measurement, especially around the lip which will

be in contact with the test earphone. Verify that the small metallic wire in the capillary leak hole is present with no other obstructions (figure 5-4).

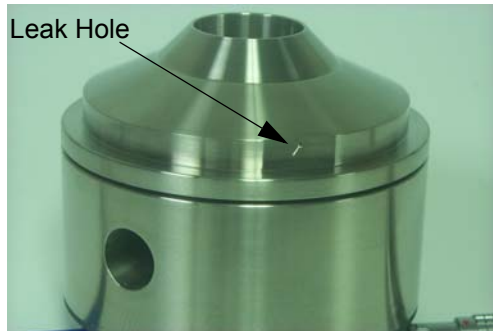


Figure 5-4 *AEC100 with coupler, leak hole.*

- Step 3** Check the threaded hole on the weight assembly (SAEC100.01) for obstructions, and screw in the mass handle (MAEC100.7). The handle should screw in securely.
- Step 4** If installed, remove the coupler cap (MAE100.3) from the artificial ear base (SP-MAE100.40) by gently unscrewing it counterclockwise (figure 5-5).



Figure 5-5 *Protective ring being removed from AEC100*

- Step 5** Inspect the spring-loaded contact at the center of the base visually. It should extend approximately 5 mm above the threaded ridge. The teflon insulator around it should be free of dust and other particles. Please do not handle the contact and protect it by keeping the coupler cap on whenever a microphone is not installed.

- Step 6** Working over the cushioned pad (ACC001), install the 1" microphone (LD Model 2575 or equivalent) on the center of the artificial ear base. The microphone should install easily: screw it finger tight (figure 5-6).



NOTE: When removing the preamplifier, unscrew it by holding on its body, not the connector sleeve.

Figure 5-6 2575 Microphone and AEC100.

- Step 7** Insert the 1/2" microphone preamplifier (LD Model PRM902 or equivalent) gently in the side port until its threads contact those of the base. The preamplifier should install easily: screw it finger tight (figure 5-7). Connect the instrument cable to the preamplifier. The coupler is now ready for level calibration.



Figure 5-7 Preamp connecting to AEC100 and Extension Cable.

AEC100 NBS 9-A Coupler SPL Calibration

Level calibration is performed with the Larson Davis Model CAL250 precision calibrator. It offers a level of 114 dB with an accuracy of ± 0.2 dB at 250Hz. To calibrate the measurement system and artificial ear, follow the procedure below.

- Step 1** Assemble the coupler as described in the Initial Inspection and Assembly section above. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.
- Step 2** Place the calibrator opening on the microphone and seat it fully (figure 5-8). Note: Do not remove the microphone grid cap.



Figure 5-8 *Cal 250 being lowered onto 2575 microphone.*

- Step 3** Activate the calibrator as prompted by the software and verify the stability of the indication on the measurement system (figure 5-9). Do not hold the calibrator during calibration. Its tone will last about one minute (depending on the battery) and will turn off automatically.



Figure 5-9 *Starting Calibration tone with on switch.*

- Step 4** AUDit™ requires a calibration in each of two measurement ranges. The calibrator tone may have to be reactivated for the second calibration as prompted by the software.
- Step 5** After the calibration, carefully remove the grid cap by holding the microphone body and unscrewing the grid counterclockwise (figure 5-10). Store it in the microphone case.



Figure 5-10 *Removing gridcap from 2575 Microphone.*

- Step 6** Replace the grid cap with the protective coupler cap (MAE100.3), being careful not to impact the delicate diaphragm (figure 5-11).



Figure 5-11 *Installing Protective Ring on 2575 Microphone.*

Testing Supra-Aural Earphones with the AEC100

The following steps are suggested for audiometer calibration with the AEC100.

- Step 1** Assemble the coupler as described in the Initial Assembly above. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.
- Step 2** Perform a calibration of the system as described in the Calibration section above and replace the microphone grid cap with the protective coupler cap (MAE100.3), being careful not to impact the delicate diaphragm.
- Step 3** As desired, apply sealant on the lower portion of the microphone to prevent air leakage from the coupler through paths other than the capillary leak

hole. Place the coupler over the base (figure 5-12). The sealant should not affect the volume of the cavity or occlude the leak hole.



Figure 5-12 *Coupler being installed on AEC100*

Step 4 For headphones with a very stiff ear cap, apply a thin (less than 1mm) film of sealant or rubber sheet on the contact area between coupler and earphone.

Step 5 Center the test earphone on the coupler. Lower the black retainer ring over the earphone, holding the earphone cable in line with the notch (figure 5-13).



Figure 5-13 *Retainer Ring being installed over headpiece.*

Step 6 Lower the mass by its handle to the top of the earphone (figure 5-14).



Figure 5-14 *Mass being installed on AEC100.*

The coupler and earphone are now ready for measurement. Set tone type, level and presentation and make the reading on the measurement system.

AEC101 IEC 318 Coupler Initial Inspection and Assembly

For this you will need:

Part Number	Description
AUDit™	AUDit™ software running on a PC
CBL006 serial cable	Serial cable 8 pin mini DIN to DB-9
824	System824 precision sound level meter (SLM)
EXA010	10 foot extension cable with 7 pin LEMO connectors
2559	1/2" precision air condenser random incidence microphone
PRM902	1/2" diameter low noise microphone preamplifier
CAL250	Precision SPL calibrator with 114 dB SPL output at 250 Hz with 1 to 1/2" calibrator opening adaptor
The following are AEC101 components:	
	Artificial ear base including base, contacts, insulator and pad
	IEC 318 coupler
MAEC100.06	IEC 318 Type 1 adaptor
MAEC100.07	IEC 318 Type 2 adaptor
MAEC100.08	IEC 318 conical ring
MAE100.6	Earphone retainer ring
MAEC100.7	Mass handle
SAEC100.01	Weight assembly
ACC001	Vibration isolation pad

WARNING! Before continuing, ensure that the 824 SLM is turned off. Sensitive circuitry may be adversely affected by transients during assembly if the 824 is on. The 824 should remain off until the system is fully assembled.

The AEC101 artificial ear is a versatile coupler and allows measurement of a variety of earphones with its provided accessories. Read the following instructions to unpack, inspect and assemble the coupler for the first time.

Step 1 Place the cushioned vibration isolation pad on a table or other such stable surface near the audiometer system.

Step 2 Visually inspect the coupler for gouges, scratches and dents which may affect the measurement, especially around the sharp lip which will be in contact with the test earphone. Verify that the small tube in the capillary leak hole is present with no other obstructions (figure 5-15).



Figure 5-15 *AEC101 with coupler, leak hole*

- Step 3** Check the threaded hole on the weight assembly (SAEC100.01) for obstructions, and screw in the mass handle (MAEC100.7). The handle should screw in securely.
- Step 4** If installed, remove the coupler from the artificial ear base by gently unscrewing it counterclockwise.
- Step 5** Inspect the spring-loaded contact at the center of the base visually. It should extend approximately 5 mm above the threaded ridge. The teflon insulator around it should be free of dust and other particles. Please do not handle the contact and protect it by keeping the coupler on whenever a microphone is not installed.

- Step 6** Working over the cushioned pad (ACC001), install the 1/2" microphone (LD Model 2559 or equivalent) on the center of the artificial ear base. The microphone should install easily: screw it finger tight (figure 5-16).



Figure 5-16 *Microphone installed on AEC101*

- Step 7** Insert the 1/2" microphone preamplifier (LD Model PRM902 or equivalent) gently in the side port until its threads contact those of the base. The preamplifier should install easily: screw it finger tight (figure 5-17).

NOTE: When removing the preamplifier, unscrew it by holding on its body, not the connector sleeve



Figure 5-17 *Preamp approaching AEC101*

- Step 8** Connect the instrument cable to the preamplifier. The coupler is now ready for level calibration.

AEC101 IEC 318 Coupler SPL Calibration

NOTE: You will need to install the adapter (ADP019) into the CAL250 in order to calibrate 1/2 inch microphones.



NOTE: Do not remove the microphone grid cap.

Level calibration is performed with the Larson Davis Model CAL250 precision calibrator. It offers a level of 114 dB with an accuracy of ± 0.2 dB at 250Hz. You will have to insert the provided 1" to 1/2" adaptor in the top of the calibrator. To calibrate the measurement system and artificial ear, follow the procedure below.

Step 1 Assemble the coupler as described in the Initial Inspection and Assembly section above. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.

Step 2 Place the calibrator opening on the microphone and seat it fully (figure 5-18).



Figure 5-18 *Installing the CAL250 on AEC101*

Step 3 Activate the calibrator as prompted by the software and verify the stability of the indication on the measurement system (figure 5-19). Do not

hold the calibrator during calibration. Its tone will last about one minute (depending on the battery) and will turn off automatically.



Figure 5-19 *CAL250 being activated on AEC101*

Step 4 AUDit™ requires a calibration in each of two measurement ranges. The calibrator tone may have to be reactivated for the second calibration as prompted by the software.

Testing Supra-Aural Earphones with the AEC101

The following steps are suggested for audiometer calibration with the AEC101.

- Step 1** Assemble the coupler as described in the Initial Assembly above. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.
- Step 2** Perform a calibration of the system as described in the Calibration section above.
- Step 3** As desired, apply sealant on the lower portion of the microphone to prevent air leakage from the coupler through paths other than the capillary leak hole. Screw the coupler over the base (figure 5-20) until finger tight. The sealant should not affect the volume of the cavity or occlude the leak hole.



Figure 5-20 *Coupler being installed on AEC101*

- Step 4** Place the black conical ring (figure 5-21) on the top of the coupler.

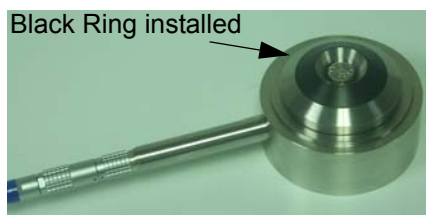


Figure 5-21 *Black Conical ring installed on AEC101*

- Step 5** For headphones with a very stiff ear cap, apply a thin (less than 1mm) film of sealant or rubber sheet on the contact area between coupler and earphone.
- Step 6** Center the test earphone on the coupler. Lower the black retainer ring over the earphone, holding the earphone cable in line with the notch (figure 5-22).



Figure 5-22 *Retainer ring being installed on AEC101*

- Step 7** Lower the mass by its handle to the top of the earphone (figure 5-23).



Figure 5-23 *Mass being lowered onto headphone.*

The coupler and earphone are now ready for measurement. Set tone type, level and presentation and make the reading on the measurement system.

Testing Circumaural Earphones with the AEC101

Circumaural earphones are available for audiometers using extended high-frequencies, from 8000 to 16000 Hz. These earphones typically rest against the head with little or no contact with the pinna (external ear). Their speaker (or driver) is coupled to the ear with a relatively large volume of air under the ear cap.

Interim RETSPLs for two circumaural earphones are listed in *Annex C of ANSI S3.6-1996*. These two types of circumaural earphones are available in AUDit™: the Sennheiser HDA200 and Koss HV/1A.

Environmental conditions

It is stated in various standards that the extended high-frequency calibration of circumaural earphones be performed only when the following environmental conditions are met.

Condition	Range in ANSI S3.6-1996 (Annex C)	Range in IEC 318-1:1998 Clause 6 Calibration
Ambient Pressure	98 to 104 kPa	98.3 to 104.3 kPa
Temperature	18 to 26 degrees C	20 to 26 degrees C
Relative Humidity	30 to 80% RH	30 to 70% RH
Any condition not met	Calibration is not allowed	State actual values

Test Configurations

The following steps are suggested for circumaural earphone audiometer calibration with the AEC101.

- Step 1** Assemble the coupler as described in the Initial Assembly above. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.
- Step 2** Perform a calibration of the system as described in the Calibration section above.

- Step 3** As desired, apply sealant on the lower portion of the microphone to prevent air leakage from the coupler through paths other than the capillary leak hole. Screw the coupler over the base (figure 5-24). The sealant should not affect the volume of the cavity or occlude the leak hole.



Figure 5-24 *Coupler being installed on AEC101*

- Step 4** For earphones designed to be calibrated with a Type 1 adapter (such as the Sennheiser HDA200), install the Type 1 adapter on the coupler, with the cylindrical rim facing down. Place the black conical ring on the top of the coupler and plate, with its flat base on the bottom (figure 5-25).

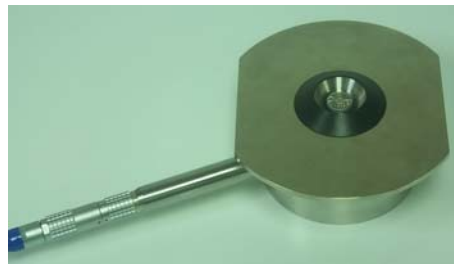


Figure 5-25 *AEC101 with Type 1 Adapter installed.*

Step 5 For earphones designed to be calibrated with a Type 2 adapter (such as the Koss HV/1A), use the Type 2 adapter, which has crenellated distance clamps around its circumference. Do not use the black conical ring (figure 5-26).



Figure 5-26 *Type 2 adapter adapter installed on AEC101.*

Step 6 Center the test earphone on the coupler or place it as recommended if the cushion is asymmetrical.

Step 7 ANSI S3.6-1996 requires a static force of 9 to 10 N on the earphone during calibration. Use the large weight (figure 5-27).



Figure 5-27 *Sennheiser earphone and weight being installed on AEC101*

The coupler and earphone are now ready for measurement. Set tone type, level and presentation and make the reading on the measurement system.

Testing Bone Vibrators with the AMC493 Artificial Mastoid

Bone vibrators are used to test sound conduction through the head from a forehead or mastoid placement. Their use is limited to a restricted frequency range. The LD AMC493 artificial mastoid uses an innovative design to allow bone vibrator calibration with an NBS 9-A coupler. The AMC493 converts the force applied by the bone vibrator to an acoustic signal which can then be measured acoustically by the calibration system. The following steps are suggested for bone vibrator transducer calibration.

In addition to the components of the AEC100 listed above, you will need the following equipment:

Part Number	Description
AMC493	Artificial mastoid
MMAS493.03	Additional ring mass

Environmental conditions

Bone vibrator calibration measurements are extremely sensitive to temperature. The artificial mastoid, and the bone vibrator itself are affected by temperature. One important advantage of the AMC493 is its very low thermal mass, which allows it to stabilize to the temperature of the test area very quickly, typically within a few tens of minutes. The sensitivity level and mechanical impedance level table or graph supplied for the AMC493 were measured at a standard temperature.

NOTE: The basis for ANSI Standard S3.13-1987 (Reaffirmed 1993) Mechanical Coupler for Measurement of Bone Vibrators is IEC 60373:1990-01 of the same name. This standard states that in general, temperature corrections can not be used directly to correct data not taken at the reference temperature of 23 degrees C, as the effect of temperature on the bone vibrator is unknown.

The temperature dependence of the mastoid is stated in its manual. Although AUDit™ performs a temperature correction, it is very strongly recommended to make measurements as close as possible to the temperature at which the AMC493 mastoid was calibrated.

Test Configuration

- Step 1** Assemble the AEC100 coupler as described in the Initial Assembly above. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.
- Step 2** Perform a calibration of the system as described in the AEC100 Calibration section above.
- Step 3** As desired, apply sealant on the lower portion of the microphone to prevent air leakage from the coupler through paths other than the capillary leak hole. Place the coupler over the base (figure 5-11). The sealant should not affect the volume of the cavity or occlude the leak hole.
- Step 4** Lightly place the blue ring-shaped polymer under the AMC493 artificial mastoid on the top of the coupler (figure 5-28). There must not be any metal to metal contact. Press down slightly on the AMC493 to secure its position.

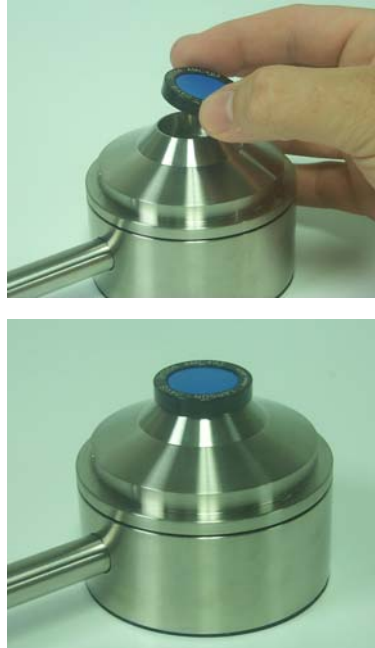


Figure 5-28 *Mastoid placed on AEC100*

- Step 5** Center the test vibrator contact surface on the circular resilient surface of the AMC493. Ensure that there is no contact between the vibrator body and the AMC493 metallic rim (figure 5-29).



NOTE: When removing the vibrator from the AMC493 artificial mastoid, gently twist the vibrator to break the seal.

Figure 5-29 *Vibrator being placed and centered on mastoid.*

- Step 6** Assemble the additional mass ring over the handle of the AEC100 mass (figure 5-30)



Figure 5-30 *Additional mass being placed on AEC100 weight*

NOTE: When removing the AMC493 artificial mastoid from the coupler, gently twist it off to break the seal.

Step 7 Lower the black retainer ring over the vibrator, holding the vibrator cable in line with the notch (figure 5-31).



Figure 5-31 *Retainer Ring being placed over vibrator.*

Step 8 Lower the mass on top of the vibrator by its handle (figure 5-32).



Figure 5-32 *Artificial ear with vibrator and mass installed.*

The coupler and vibrator are now ready for measurement. Set tone type, level and presentation and make the reading on the measurement system.

Testing Bone Vibrators with the B&K 4930 or other Artificial Mastoid

Unlike the LD AMC493, the Brüel & Kjær artificial mastoid uses an accelerometer to measure the bone vibrator output. The LD audiometer calibration system can interface with the B&K mastoid by using the high input impedance PRM902 preamplifier and a suitable adapter.

If the cable from the B&K 4930 has a 10-32 microdot connector (small threaded coaxial connector), use the ADP007. On the other hand, if your artificial mastoid has a BNC coaxial connector, use the ADP006 provided with the LD system (figure 5-33). You will also need:

Part Number	Description
AUDit™	AUDit™ software running on a PC
CBL006	Serial cable 8 pin mini DIN to DB-9
824	System824 precision sound level meter (SLM)
PRM902	1/2" diameter low noise microphone preamplifier
ADP008	1" microphone to 1/2" preamp adapter
2575	1" precision air condenser microphone
CAL250	Precision SPL calibrator with 114 dB SPL output at 250 Hz
B&K 4930	Artificial Mastoid and accessories
ADP007 or ADP006	Microdot to 1/2" preamp adapter for charge-coupled accelerometer or BNC to 1/2" microphone thread adapter, 47 pF with shorting cap



Figure 5-33 *Adapters to connect to B & K mastoid.*

Environmental conditions

Bone vibrator calibration measurements are extremely sensitive to temperature. The artificial mastoid and the bone vibrator are both affected by temperature. The large thermal mass of the B&K 4930 may take several hours to attain thermal equilibrium. It is therefore not adequate to depend on a measurement of room temperature. One possible procedure is to keep the B&K 4930 in a thermostatically controlled environment at room temperature for several hours before use.

NOTE: The basis for ANSI Standard S3.13-1987 (Reaffirmed 1993) Mechanical Coupler for Measurement of Bone Vibrators is IEC 60373:1990-01 of the same name. This standard states that in general, temperature corrections can not be used directly to correct data not taken at the reference temperature of 23 degrees C, as the effect of temperature on the bone vibrator is unknown.

It is very strongly recommended to make measurements as close as possible to the temperature at which the artificial mastoid was calibrated.

Test Configuration

- Step 1** Assemble the measurement system as in the section on: Connecting the PC, 824 and PRM902 Preamplifier.
- Step 2** Thread the ADP008 onto the preamplifier and then thread the 2575 microphone on the preamplifier (figure 5-34).



Figure 5-34 *ADP008 being installed on PRM902.*

- Step 3** Perform a system SPL calibration with the CAL250.

Step 4 Remove the ADP008 adaptor and 2575 microphone, and replace them with the appropriate adaptor to connect to the artificial mastoid (figure 5-35).



Figure 5-35 *Adapters to connect to B & K mastoid.*

Step 5 Install the bone vibrator on the B&K 4930 as described in the B & K user manual.

The coupler and vibrator are now ready for measurement. Set tone type, level and presentation and make the reading on the measurement system.

Hearing Level Test

Once AUDit™ has been configured with the test instrumentation and audiometer information, an actual audiometer calibration may be performed. The main measurement screen is accessed from the Audiometer Test Setup screen by pressing the **OK** button.

Calibration Main Measurement Screen

AD226-004 005 97 - AUDit

File Test View Report SLM Help

Test Date: year: 1999 month: Apr day: 1

Audiometer: Interacoustics AD226 SN:004 005 97

Calibration Technician: Spiro Cochler

Test	Supra-aural Earphones	Bone vibrator	Speakers	Insert Earphones	Circumaural Earphones
Hearing Level	-	-	-	-	-
Frequency	-	n/a	n/a	-	-
Linearity	-	n/a	n/a	-	-
Harmonic Distortion	-	-	n/a	-	-
Pulse	FAIL	n/a	n/a	-	-
Cross Talk	-	n/a	n/a	-	-
Frequency Modulation	-	n/a	n/a	-	-
Narrow Band Level	-	n/a	-	-	-
Broad Band Noise	-	n/a	n/a	-	-
Speech	-	-	-	-	n/a

Go To Measurement... Back to Setup... Done

For Help, press F1

Figure 6-1 *Main Measurement Screen*

The main measurement screen (figure 6-1) allows one to enter the test date and technician name. The tested audiometer manufacturer, model and serial number are displayed as entered in the previous setup. A table of tests and transducers shows the available tests for the particular audiometer. For example, the Hearing Level test may be performed with

supra-aural, insert or circumaural earphones, as well as with the bone vibrator and speakers. Appropriate corrections are applied within each test using microphone, coupler and standard adjustments.

NOTE: *The SLM should be calibrated before a measurement is performed.*

To begin the audiometer calibration process, highlight the **Hearing Level test** with the pointer and press the **Go To Measurement** button. If you are already in a test screen, press the same test in the Measurements window at the upper left.

Hearing Level Test with Earphone Transducers

AD226-004 005 97 - AUDit

File Test View Report SLM Help

Measurements

Hearing Level

Low Freq. Input Levels High Freq. Input Levels Left Right

125	70	750	70	3000	70
160	70	800	70	3150	70
200	70	1000	70	4000	70
250	70	1250	70	5000	70
315	70	1500	70	6000	70
400	70	1600	70	6300	70
500	70	2000	70	8000	70
630	70	2500	70		

Adjust Measure All Measure Selected Next Test Ok Cancel

For Help, press F1

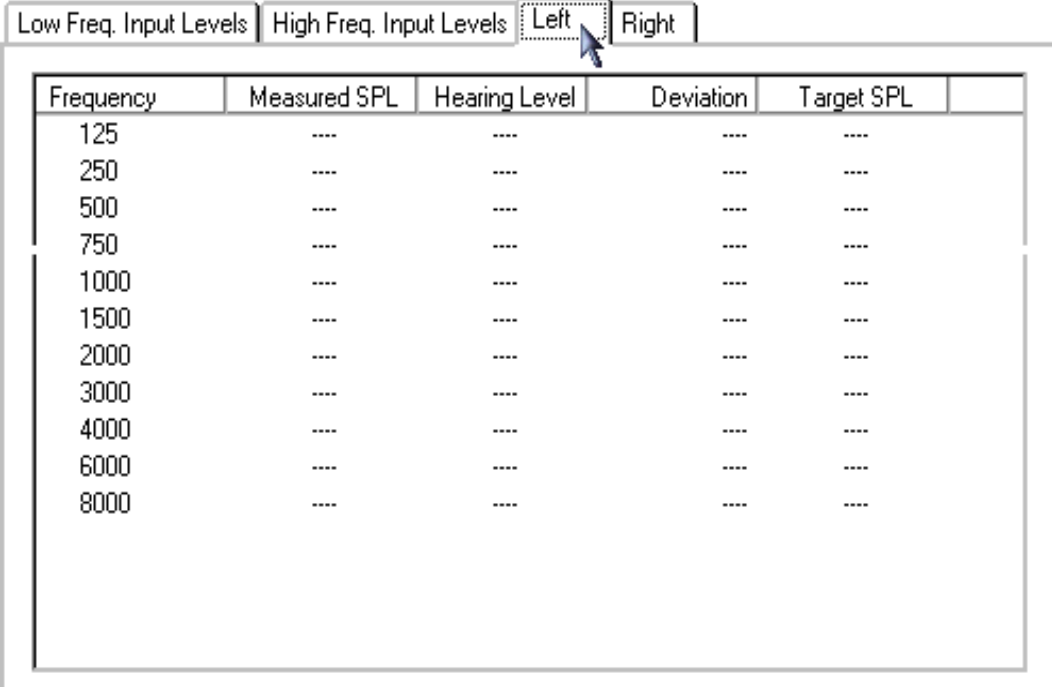
Figure 6-2 *Hearing Level Screen*

The Hearing Level screen (figure 6-2) is typical of the measurement screens. On the left, below the measurement table, you will find the list of transducers for which the audiometer hearing level may be tested. The large box at the right has multiple tabs and varies according to the transducer being tested. For example, all earphones types have four tabs: Low

and High Freq. Input levels, Left and Right. On the other hand, the bone vibrator has only two tabs: Input levels and Bone Vibrator Levels. In this section, the supra-aural earphone transducers will be calibrated. The procedure is the same for insert and circumaural earphones.

To perform a test of the supra-aural earphones, highlight the Supra-aural Earphone transducer list item. The four Supra-aural Earphone Hearing Level tabs will appear on the right part of the screen. Default low and high frequency input levels are typically set to 70 dB HL on each tab. Each value may be changed by highlighting it and entering a new value. Use the pointer or the TAB key to move to another frequency.

Once the input levels have been verified, one may select which earphone to test by pressing on the Left or Right tab.



Frequency	Measured SPL	Hearing Level	Deviation	Target SPL
125	---	---	---	---
250	---	---	---	---
500	---	---	---	---
750	---	---	---	---
1000	---	---	---	---
1500	---	---	---	---
2000	---	---	---	---
3000	---	---	---	---
4000	---	---	---	---
6000	---	---	---	---
8000	---	---	---	---

Figure 6-3 *Active Frequencies List*

The list of the active frequencies selected earlier in the audiometer setup appears in the right window (figure 6-3). Note

the headers at the top of the table. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed.

The row of buttons at the bottom of the screen allows the technician to:

- Adjust - adjust the audiometer in real-time if a precision output level adjustment is available
- Measure All - measure all frequencies sequentially with software prompts
- Measure Selected - measure only the currently highlighted frequency with software prompts
- Next Test - move to the next measurement in the Measurements list in the upper left window
- OK - end the current test
- Cancel - cancel the current test

Press **Measure All** to perform a hearing level test on the left earphone. AUDit™ then displays the prompt shown in figure 6-4 for the first frequency:

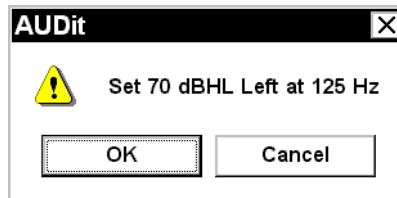


Figure 6-4 *Prompt for First Frequency Setting*

Set the appropriate level and frequency on the audiometer then press **OK**. Each frequency will be tested until all have been measured. This can be done in less than one minute by pressing the audiometer frequency increment button and then immediately pressing the Enter (OK) key on the computer. In the above example, all frequencies passed except for the last 8000 Hz (figure 6-5). This is indicated by a large red X next to the frequency.

Low Freq. Input Levels		High Freq. Input Levels		Left	Right
Frequency	Measured SPL	Hearing Level	Deviation	Target SPL	
125	117.2	69.7	-0.3	114.5 to 120.5	
250	95.4	68.9	-1.1	93.5 to 99.5	
500	82.0	68.5	-1.5	80.5 to 86.5	
750	77.4	68.9	-1.1	75.5 to 81.5	
1000	76.5	69.0	-1.0	74.5 to 80.5	
1500	76.6	69.1	-0.9	74.5 to 80.5	
2000	81.1	70.1	0.1	78.0 to 84.0	
3000	79.4	69.9	-0.1	76.5 to 82.5	
4000	78.8	68.3	-1.7	77.5 to 83.5	
6000	80.9	67.4	-2.6	78.5 to 88.5	
X 8000	71.0	58.0	-12.0	78.0 to 88.0	

Figure 6-5 *Frequency Test Screen*

It may be desired to adjust this level by pressing the Adjust button. A small dialog box (figure 6-6) is then displayed where the technician may select the current frequency and adjust the level potentiometer of the audiometer to fall within the listed target SPL range.

Adjust Level

Measured SPL

dBHL

Frequency

83.1

70.1

8000

OK

Figure 6-6 *Measure Selected Frequency Dialog Box*

Once this is done, the failed frequency may be retested with the Measure Selected button.

Hearing Level Test with Bone Vibrator

1716-5804 - AUDit

File Test View Report SLM Help

Measurements

- Hearing Level
- Frequency
- Linearity
- Distortion
- Pulse
- Cross Talk
- Freq. Modulation
- Narrow Band Level
- Broad Band Noise
- Speech

Transducers

- Supra-aural Earphone
- Bone Vibrator
- Speakers
- Insert Earphone
- Circumaural Earphone

Hearing Level

Input Levels Bone Vibrator Levels

☒ Use defaults Set to defaults

Bone vibrator input levels

250	20	1000	40	3150	40
315	40	1250	40	4000	40
400	40	1500	40	5000	40
500	40	1600	40	6000	40
630	40	2000	40	6300	40
750	40	2500	40	8000	40
800	40	3000	40		

Adjust Measure All Measure Selected Next Test Ok Cancel

For Help, press F1 NUM

Figure 6-7 *Hearing Level Test with Bone Vibrator Screen*

To perform a test of the bone vibrator transducer, highlight the Bone Vibrator transducer list item. The Hearing Level screen (figure 6-7) for the bone vibrator transducer has two tabs: Input Levels and Bone Vibrator Levels. In the first tab, the test bone vibrator levels can be specified or set to default values. Use the pointer or TAB key to move from one frequency to another. The Bone Vibrator Levels tab displays calibration results.

Input Levels

Bone Vibrator Levels

Placement:
☒ Mastoid
☐ Forehead

Frequency	Measured SPL	Hearing Level	Deviation	Target SPL	
250	----	----	----	----	
500	----	----	----	----	
750	----	----	----	----	
1000	----	----	----	----	
1500	----	----	----	----	
2000	----	----	----	----	
3000	----	----	----	----	
4000	----	----	----	----	
6000	----	----	----	----	
8000	----	----	----	----	

Figure 6-8 *Bone Vibrator Levels Tab*

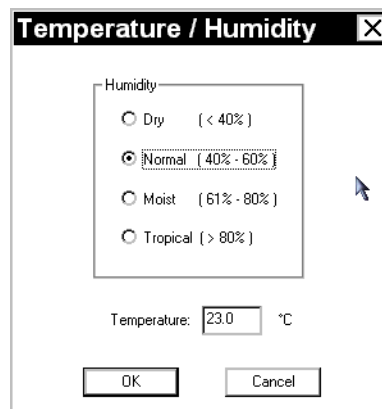
The list of the active frequencies selected earlier in the audiometer setup appears in the right window (figure 6-8). Placement of the bone vibrator affects output. Select the proper option: Mastoid or Forehead. Note the headers at the top of the table. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed.

The row of buttons at the bottom of the screen allows the technician to:

- Adjust - adjust the audiometer in real-time if a precision output level adjustment is available
- Measure All - measure all frequencies sequentially with software prompts
- Measure Selected - measure only the currently highlighted frequency with software prompts

- Next Test - move to the next measurement in the Measurements list in the upper left window
- OK - end the current test
- Cancel - cancel the current test

Press **Measure All** to perform a hearing level test on the bone vibrator. If you are using a Larson Davis mastoid, you will be prompted to enter temperature and humidity values (figure 6-9) used within the software for artificial mastoid corrections.



The screenshot shows a dialog box titled "Temperature / Humidity" with a close button (X) in the top right corner. Inside the dialog, there is a section labeled "Humidity" containing four radio button options: "Dry (< 40%)", "Normal (40% - 60%)", "Moist (61% - 80%)", and "Tropical (> 80%)". The "Normal" option is selected. Below the humidity options is a text input field labeled "Temperature:" containing the value "23.0" followed by a unit label "°C". At the bottom of the dialog are two buttons: "OK" and "Cancel".

Figure 6-9 *Temperature/Humidity Entry Screen*

Enter the humidity range, dry, normal, moist or tropical, as well as the temperature in degrees centigrade

Hint: $(\text{degrees } C = (\text{degrees } F - 32) \times 5 / 9)$.

AUDit™ then displays the prompt shown in figure 6-10 for the first frequency:

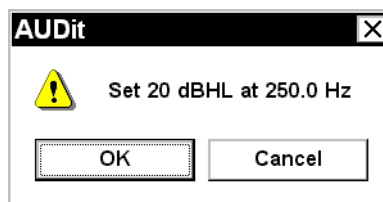


Figure 6-10 *Hearing Level Set Screen*

Set the appropriate level and frequency then press **OK**. Each frequency will be tested until all have been measured consecutively. This can be done in less than one minute by pressing the audiometer frequency increment button and then immediately pressing the Enter (OK) key on the computer.

Hearing Level Test with Speakers

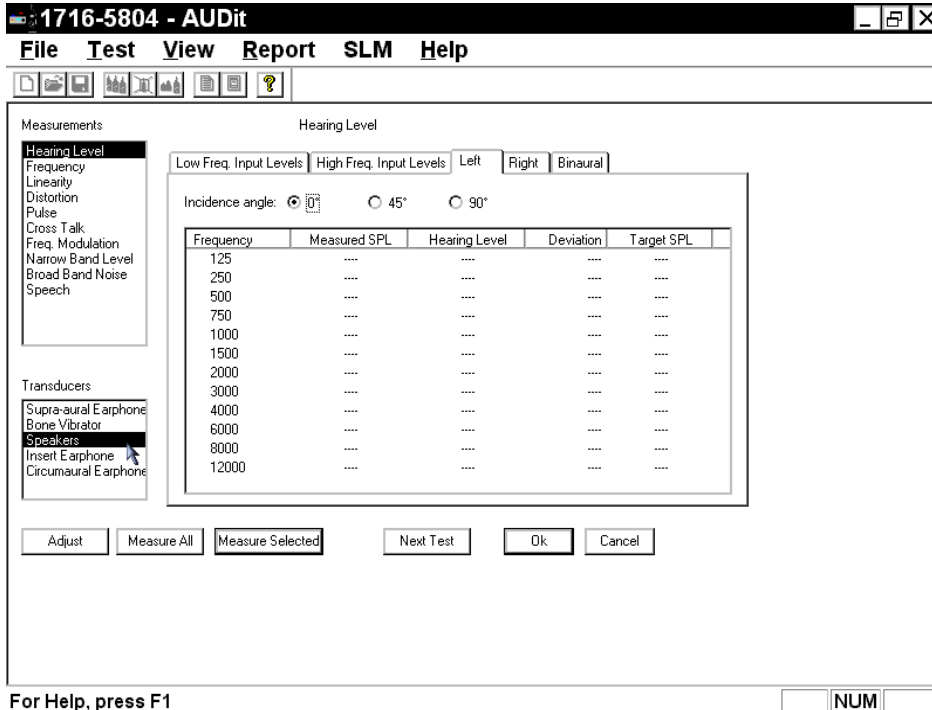


Figure 6-11 *Hearing Level Test with Speakers Screen*

Sound field audiometric testing using speakers may be performed in a variety of ways. Table 9 of ANSI S3.6-1996 lists reference equivalent threshold sound pressure levels (RETSPL) for binaural listening in free field at 0 degree incidence, as well as monaural listening for 0, 45 and 90 degree incidence. These RETSPLs are used in AUDit™ to translate the measured sound pressure levels to hearing levels. Note that the prescriptions in section 9.5.1 of the standard for sound field characteristics should be followed. These include the requirement that the ambient noise in the sound field shall not exceed that specified in ANSI S3.1-1991. The ambient noise booth test in AUDit™ is helpful in making this determination.

To perform a test using speakers, highlight the **Speakers** transducer list item. The Hearing Level screen (figure 6-11) for the speakers transducers has five tabs: Low and High

Freq. Input Levels, Left, Right and Binaural. In the first two tabs, the speaker test levels can be specified for audiometric frequencies from 125 to 20000 Hertz. Use the pointer or TAB key to move from one frequency to another and enter the desired test level.

The remaining tabs select the speaker(s) to be tested: left, right or both (binaural). In this example, the Left tab is selected. An incidence angle of 0, 45 or 90 degrees must be chosen so that the appropriate RETSPL correction is applied. Note the headers at the top of the table. Measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed. The Right tab operates in exactly the same manner. The Binaural tab has only one incidence angle selection, zero degrees.

The row of buttons at the bottom of the screen allows the technician to:

- Adjust - adjust the audiometer in real-time if a precision output level adjustment is available
- Measure All - measure all frequencies sequentially with software prompts
- Measure Selected - measure only the currently highlighted frequency with software prompts
- Next Test - move to the next measurement in the Measurements list in the upper left window
- OK - end the current test
- Cancel - cancel the current test

Press **Measure All** to perform a hearing level test using the speakers. Since frequency modulation is required for this test, you will also be prompted to select a FM test signal (figure 6-12).

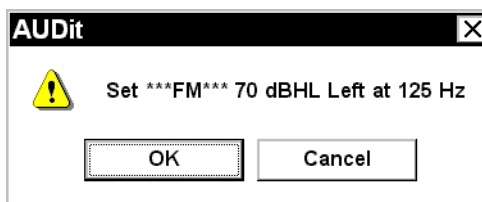


Figure 6-12 *Level and Frequency Set Dialog*

Set the appropriate level and frequency then press **OK**. Each frequency will be tested until all have been measured consecutively. This test can be performed in less than one minute by pressing the audiometer frequency increment button and then immediately pressing the Enter key (OK) on the computer.

Frequency Test

Once AUDit™ has been configured with the test instrumentation and audiometer information, an actual audiometer calibration may be performed. The main measurement screen is accessed from the Setup screen by pressing the **OK** button.

Calibration Main Measurement Screen

1716-5804 - AUDit

File Test View Report SLM Help

Test Date: year: 1999 month: Apr day: 01

Audiometer: Grason Stadler 1716 SN:5804

Calibration Technician: Spiro Cochler

Test	Supra-aural Earphones	Bone vibrator	Speakers	Insert Earphones	Circumaural Earphones
Hearing Level	Pass	FAIL	-	-	-
Frequency	-	n/a	n/a	-	-
Linearity	-	n/a	n/a	-	-
Harmonic Distortion	-	-	n/a	-	-
Pulse	-	n/a	n/a	-	-
Cross Talk	-	n/a	n/a	-	-
Frequency Modulation	-	n/a	n/a	-	-
Narrow Band Level	-	n/a	-	-	-
Broad Band Noise	-	n/a	n/a	-	-
Speech	-	-	-	-	n/a

Go To Measurement... Back to Setup... Done

For Help, press F1 NUM

Figure 7-1 *Main Measurement screen*

The main measurement screen (figure 7-1) allows one to enter the test date and technician name. The tested audiometer manufacturer, model and serial number are displayed as entered in the previous setup. A table of tests and transduc-

ers shows the available tests for the particular audiometer. For example, the Frequency test may be performed with supra-aural, insert or circumaural earphones. Appropriate corrections are applied within each test using appropriate microphone, coupler and standard adjustments.

To continue the audiometer calibration process, highlight the **Frequency** test with the pointer and press the **Go To Measurement** button. If you are already in a test screen, press the same test in the Measurements window. Note that the SLM should be calibrated before a measurement is performed.

Frequency Test with Earphone Transducers

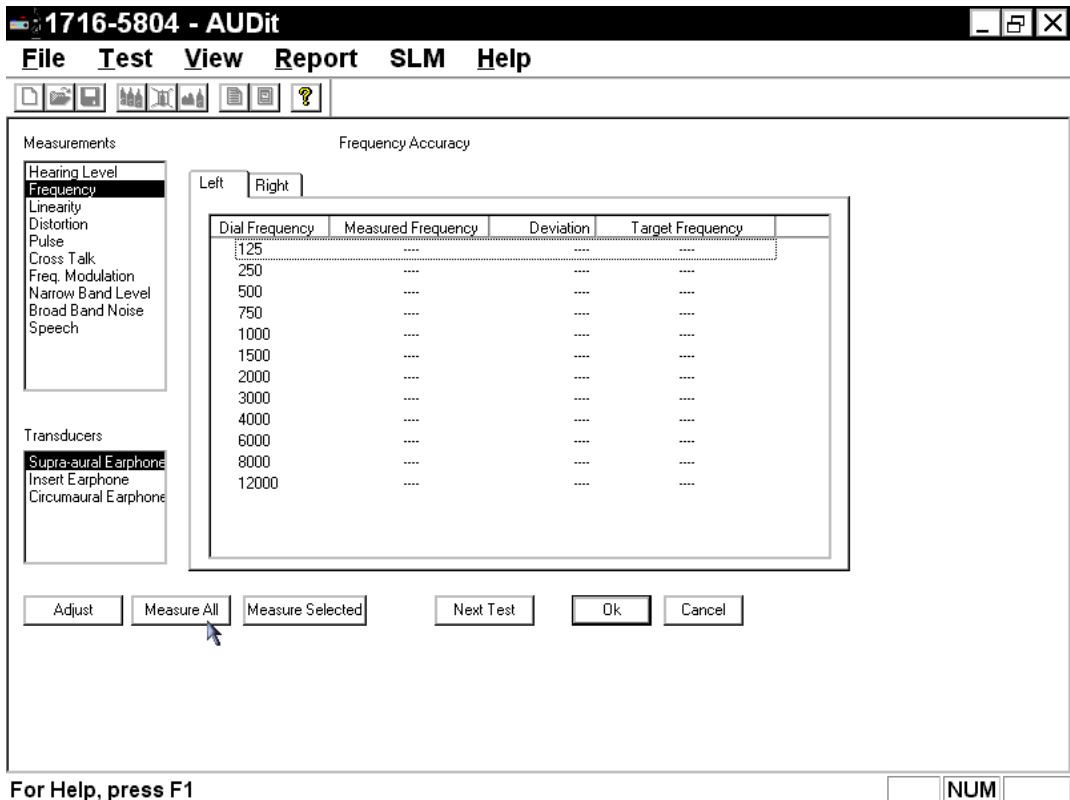


Figure 7-2 *Frequency Test Screen*

The Frequency test screen (figure 7-2) is the same for all earphone types. On the left, below the measurement table, the transducers list contains supra-aural, insert and circumaural earphones. All earphones types have two tabs: Left and Right. In this example, the supra-aural earphone transducers will be calibrated. The procedure is the same for insert and circumaural earphones.

To perform a test of the supra-aural earphones, highlight the ***Supra-aural Earphone*** transducer list item. The Supra-aural Earphone Frequency Accuracy tabs will appear on the right part of the screen. One may select the test earphone by pressing on the **Left** or **Right** tab.

The list of the active frequencies selected earlier in the audiometer setup process appears in the right window. Note the headers at the top of the table. The dial and measured frequency value from the sound level meter are displayed, and the deviation from the target frequency is displayed for each frequency.

The row of buttons at the bottom of the screen allows the technician to:

- Adjust - this is unavailable in this mode
- Measure All - measure all frequencies sequentially with software prompts
- Measure Selected - measure only the currently highlighted frequency with software prompts
- Next Test - move to the next measurement in the Measurements list in the upper left window
- OK - end the current test
- Cancel - cancel the current test

Press **Measure All** to perform a frequency test on the left earphone. AUDit™ then displays the prompt shown in figure 7-3 for the first frequency:

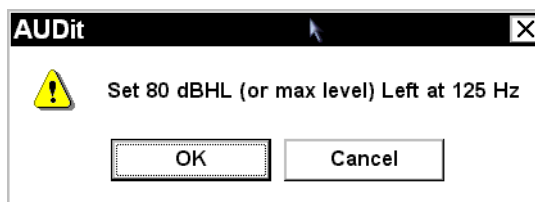


Figure 7-3 *Set Level and Frequency Dialog Box*

Set the appropriate level and frequency then press **OK**. Each frequency will be tested until all have been measured consecutively. Frequency measurement is performed accurately by a dedicated counter in the Model 824 sound level meter. A number of counter values are compared to ensure an accurate reading. This process may take a few seconds. In this example, all frequencies higher than 750 Hz are out of tolerance.(figure 7-4) This is indicated by a large red X next to each frequency.

Left Right				
Dial Frequency	Measured Frequency	Deviation	Target Frequency	
125	124.7	-0.3	123.8 to 126.2	
250	249.5	-0.5	247.5 to 252.5	
500	497.3	-2.7	495.0 to 505.0	
750	745.7	-4.3	742.5 to 757.5	
X 1000	988.7	-11.3	990.0 to 1010.0	
X 1500	1484.7	-15.3	1485.0 to 1515.0	
X 2000	1972.5	-27.5	1980.0 to 2020.0	
X 3000	2959.4	-40.6	2970.0 to 3030.0	
X 4000	3943.9	-56.1	3960.0 to 4040.0	
X 6000	5917.8	-82.3	5940.0 to 6060.0	
X 8000	7850.3	-149.7	7920.0 to 8080.0	
X 12000	11830.6	-169.4	11880.0 to 12120.0	

Figure 7-4 *Frequency Test Results Box*

NOTE: *If the frequency reading is not stable, it could be due to noise that is coupled into the artificial ear. Possible sources are HVAC, ambient noise, (room noise) or vibration. Make sure to use the pad and test on a solid surface. Verify that the ambient noise levels are satisfactorily low.*

A failed frequency may be retested after adjustment by highlighting it and pressing the **Measure Selected** button. The **Adjust** button is inactive in this screen because frequency measurements are slightly longer and the display is not effective for adjustment in real time AUDit™.

Follow the same procedure to test the right earphone.

Linearity Test

Various requirements regarding signal level controls appear in section 7 of ANSI S3.6-1996. Acceptable hearing level control linearity is specified in section 7.3.3 essentially as follows: the measured difference between two output HL settings not more than five decibels apart on the audiometer shall not vary more than three tenths or one decibel (whichever is smaller) from the indicated difference.

AUDit™ allows the measurement of linearity from the maximum hearing level down to the noise floor of the measurement system. The test frequency, maximum dBHL and dial step may be selected by the technician. Defaults are 1000 Hz frequency, 110 dBHL maximum level and 5 dBHL steps.

Linearity Measurement Screen

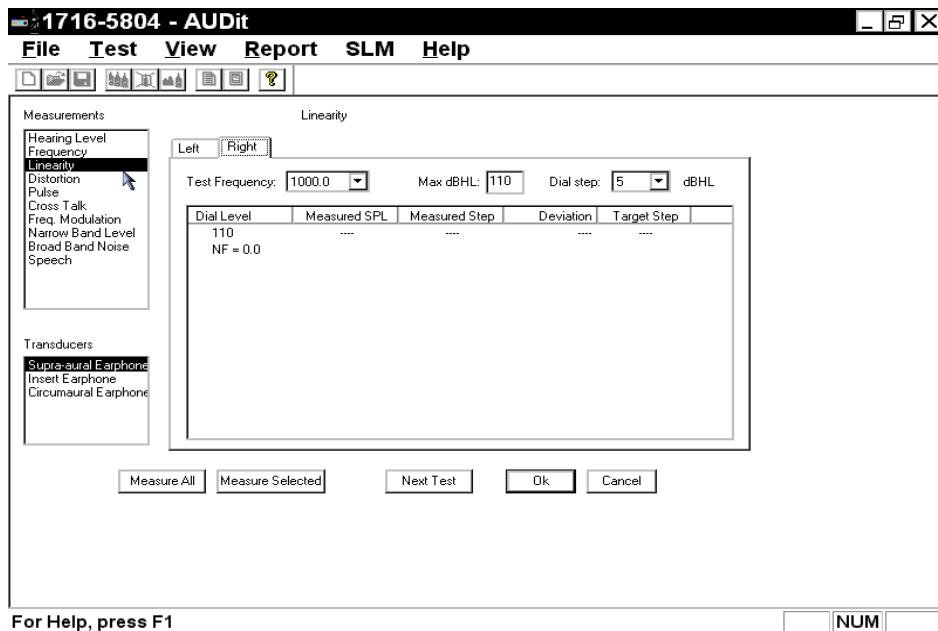


Figure 8-1 *Linearity Measurement Screen*

To perform a linearity test from the main audiometer test status screen, highlight the **Linearity** test with the pointer and press the **Go To Measurement** button. If you are already in a test screen, press the same test in the Measurements window. Note that the SLM should be calibrated before a measurement is performed. On the left, below the measurement table, (figure 8-1) the Transducers list contains supra-aural, insert and circumaural earphones. All earphone types have two tabs: Left and Right. In this example, the supra-aural earphone transducers will be calibrated. The procedure is the same for insert and circumaural earphones.

NOTE: *The headers at the top of the table. Measured SPL from the sound level meter will be displayed, and the deviation from the target step calculated for each level difference.*

Highlight the **Supra-aural Earphone** transducer list item. The Supra-aural Earphone Linearity tabs will appear on the right part of the screen. One may select which earphone to test by pressing on the Left or Right tab. Select the desired frequency and dial step (10, 5 or 1 dB) from the drop down lists and enter the appropriate maximum output level of the audiometer.

The row of buttons at the bottom of the screen allows the technician to:

- Measure All - measure all levels sequentially with software prompts
- Measure Selected - measure only the currently highlighted output level with software prompts
- Next Test - move to the next measurement in the Measurements list in the upper left window
- OK - end the current test
- Cancel - cancel the current test

Press **Measure All** to perform a linearity test on the right earphone. AUDit™ then displays the prompt shown in figure 8-2 to measure the lower end of the test range:

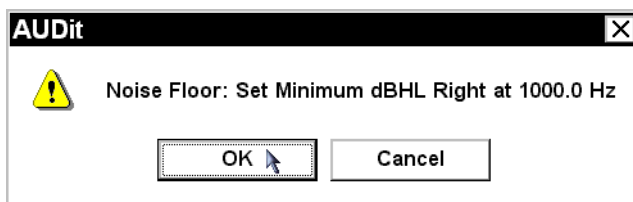


Figure 8-2 *Level and Frequency Set Dialog Box*

Hint: To test only a certain part of the hearing level control linearity; 1. set the upper level in the **max dBHL** entry field. Then present the lower level on the audiometer during the noise floor test.

Set the appropriate level and frequency then press **OK**. There may be a delay while the measurement system gain is adjusted. Once the noise floor has been measured (e.g. 0.6 dB), it will appear on the Linearity screen (figure 8-3).

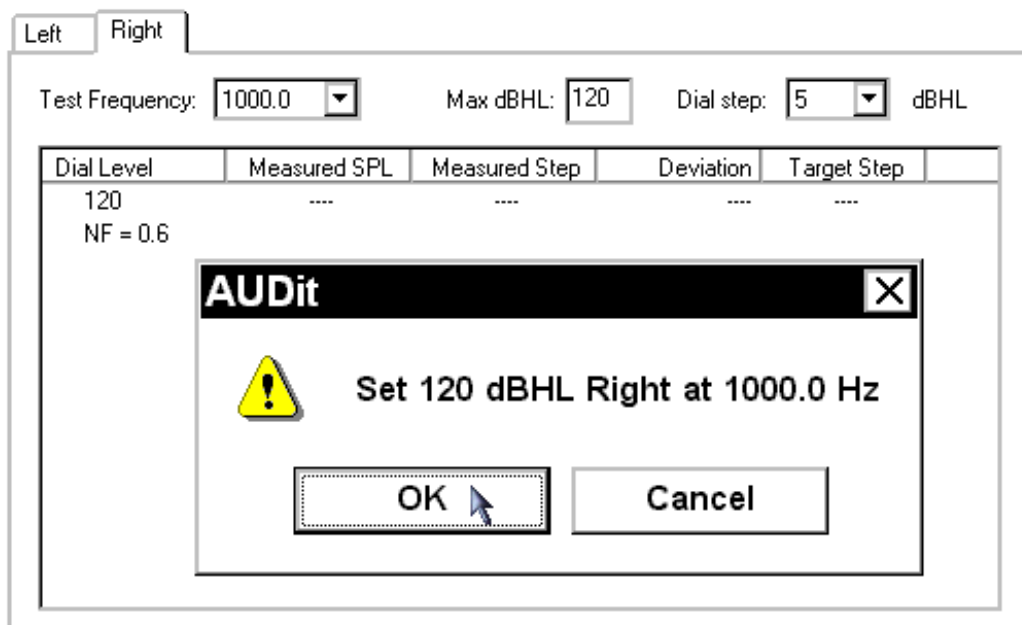


Figure 8-3 *Noise Floor Dialog Box*

All level steps from the maximum level to the noise floor will be tested consecutively with AUDit™ prompts to

change the level. Steps which are out of tolerance will be indicated by a large red X on the results screen. (Figure 8-4)

Left

Right

Test Frequency: 1000.0
Max dBHL: 120
Dial step: 5 dBHL

Dial Level	Measured SPL	Measured Step	Deviation	Target Step	
120	127.5	0.0	0.0	4.0 to 6.0	
115	122.6	4.9	-0.1	4.0 to 6.0	
110	117.9	4.7	-0.3	4.0 to 6.0	
105	113.1	4.8	-0.2	4.0 to 6.0	
100	108.0	5.1	0.1	4.0 to 6.0	
95	102.9	5.1	0.1	4.0 to 6.0	
90	97.8	5.1	0.1	4.0 to 6.0	
85	92.7	5.2	0.2	4.0 to 6.0	
80	87.6	5.0	0.0	4.0 to 6.0	
75	83.0	4.6	-0.4	4.0 to 6.0	
70	77.9	5.1	0.1	4.0 to 6.0	
65	73.2	4.7	-0.3	4.0 to 6.0	
60	68.1	5.1	0.1	4.0 to 6.0	

Figure 8-4 *Noise Floor Test Results Screen*

A failed level may be retested after adjustment by highlighting it and pressing the **Measure Selected** button. Follow the same procedure to test the other earphone.

Distortion Test

The Larson Davis audiometer calibration system performs accurate distortion measurements of the pure tone signal source by using narrow band fast fourier transform (FFT) analysis. Distortion components can affect audiometric evaluations and may indicate hardware problems. The maximum permissible levels in percent are listed in Table 4 of ANSI S3.6-1996. In general, total harmonics should be less than 2.5% for air conduction and less than 5.5% for bone conduction.

Harmonic distortion is to be measured at the levels listed in the table or the maximum hearing level of the audiometer, whichever is lower. Limitations in the frequency response of the measurement system dictate that distortion measurements above 5000 Hz should be made across the electrical terminals of the transducer. The ADP010 Audiometer Earphone Testing Adaptor is ideal for this purpose. Insert it in the connection to the transducer, and then connect its BNC to the ADP006 BNC to 1/2" preamplifier adaptor on the PRM902.

Total harmonic distortion is defined as follows:

$$THD(percent) = 100 \sqrt{\left(\frac{f_2}{f_1}\right)^2 + \left(\frac{f_3}{f_1}\right)^2} \dots$$

where f_1 is the fundamental frequency, f_2 the second harmonic, etc. Levels must be expressed in linear units in this formula.

Harmonic Distortion Measurement Screen

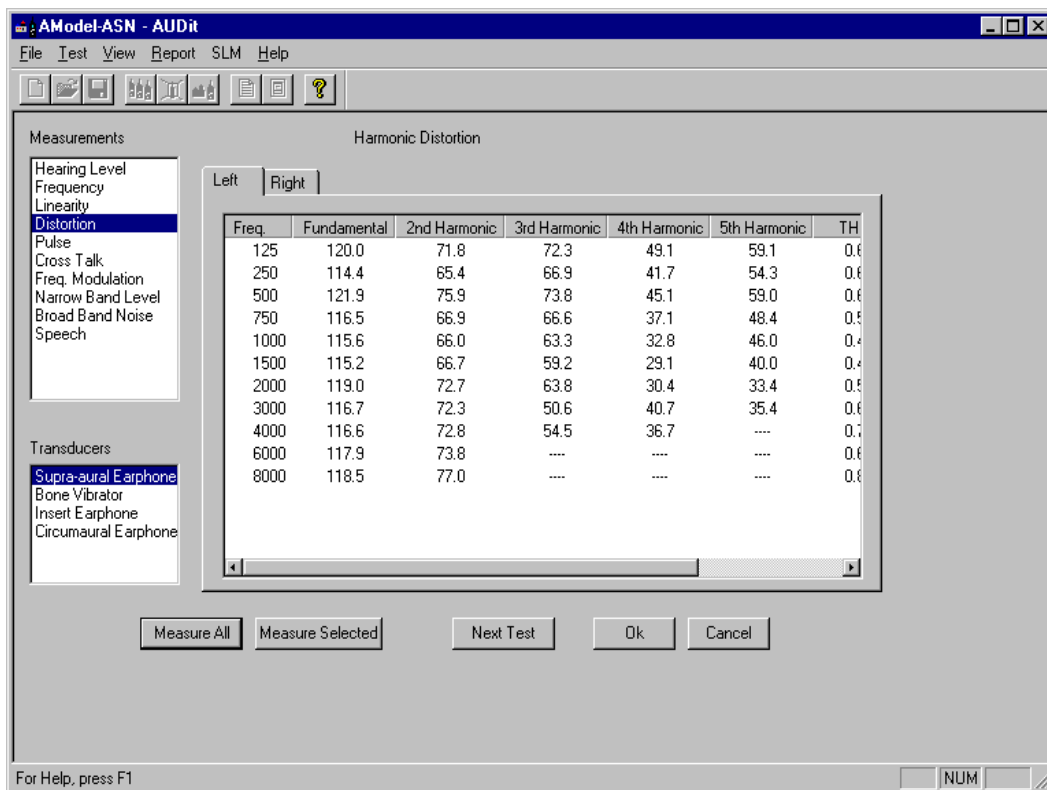


Figure 9-1 *Harmonic Distortion Test Screen*

NOTE: Notice that some of the data is scrolled off to the right of the screen. Because there is not enough to show all of the data on one screen, the scroll bar will need to be used to see the rest of the data. Figure 9-3 shows the Harmonic Distortion Test Screen scrolled to the right.

To perform a distortion test from the main audiometer test status screen, highlight the **Harmonic Distortion** test with the pointer and press the **Go To Measurement** button. If you are already in a test screen (figure 9-1), press the same test in the Measurements window. Note that the SLM should be calibrated before a measurement is performed. On the left, below the Measurement table, the Transducers list contains supra-aural earphone, bone vibrator, insert and circumaural earphones. All earphones types have two tabs: Left and Right. The bone vibrator has only one tab. In this example, the supra-aural earphone transducers will be calibrated. The procedure is nearly the same for all transducers. Remember to use the electrical terminal adaptor for frequencies above 5000 Hz.

Highlight the Supra-aural Earphone transducer list item. The Supra-aural Earphone tabs will appear on the right part of the screen (figure 9-1). You may select which earphone to test by pressing on the Left or Right tab.

The row of buttons at the bottom of the screen allows the technician to:

- Measure All - measure all levels sequentially with software prompts
- Measure Selected - measure only the currently highlighted output level with software prompts
- Next Test - move to the next measurement in the Measurements list in the upper left window
- OK - end the current test
- Cancel - cancel the current test

Press **Measure All** to perform a distortion test on the left earphone. AUDit™ then displays the prompt shown in figure 9-2 to measure the first frequency:

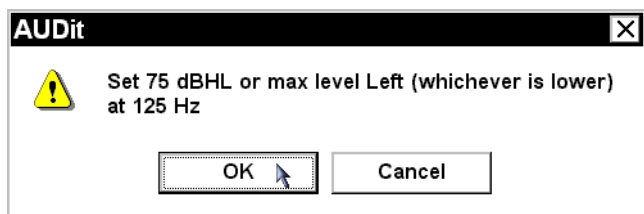


Figure 9-2 *Level and Frequency Set Dialog Box*

Set the appropriate level and frequency then press **OK**. There may be a delay while the measurement system gain is adjusted. Each frequency will be tested consecutively. When reaching the higher frequencies, it will be necessary to use the ADP010 and ADP006 combination to measure distortion on the electrical signal.

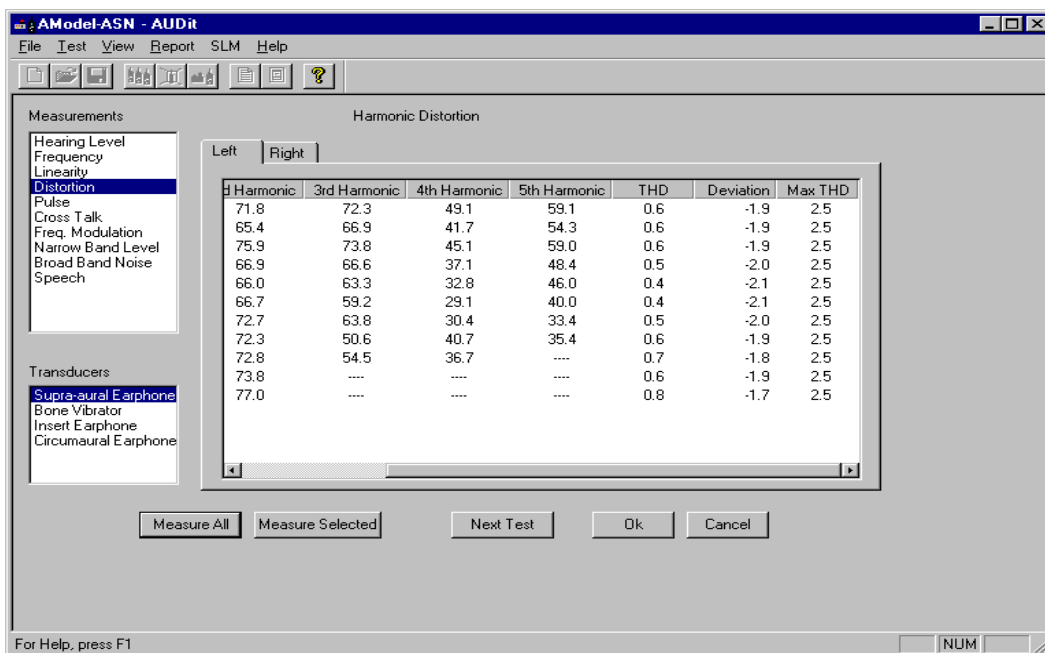


Figure 9-3 *THD Test Results Screen*

The results of the distortion measurement are listed in the tab (figure 9-3), with each harmonic's level in dB and the total harmonic distortion in percent. Frequencies which are out of tolerance will be indicated by a large red X.

A failed frequency may be retested after adjustment by highlighting it and pressing the **AUDit™** button. Follow the same procedure to test the remaining transducers.

Pulse Test

In some audiometry cases, the presentation of pulsed tones is preferred. The Larson Davis audiometer calibration system performs accurate pulse measurements of the pure tone signal source by using digital signal processing techniques. Requirements for the envelope of pulsed pure tone signals are listed in section 7.5.4 of ANSI S3.6-1996. The relevant parameters for the automatically pulsed tones are defined below:

- Frequency: fundamental rate of change of the pure tone signal in hertz
- Rise Time: time in milliseconds between the -20 dB point (referred to the maximum level) and -1 dB point on the rising edge of the pulsed signal envelope, nominally between 20 and 50 ms
- Fall Time: time in milliseconds between the -1 dB point and -20 dB point on the falling edge of the pulsed signal envelope, nominally between 20 and 50 ms
- On Time: time in milliseconds between successive -5 dB points of the envelope of the pulsed signal during which the signal is present, nominally between 190 and 260 ms
- Off Time: time in milliseconds between successive -5 dB points of the envelope of the pulsed signal during which the signal is absent, nominally between 190 and 260 ms
- Width: duration in milliseconds of the plateau during which the signal is within -1 dB of its nominal value
- On/Off Ratio: ratio of the maximum level during the "OFF" portion of the pulse between the -20 dB point of the falling and rising edge of the envelope to the maximum level in the "ON" portion, nominally greater than 20 dB

Pulse signal envelope characteristics are measured at a nominal frequency of 1000 Hz in AUDit™. However, the mea-

surement may be made with another available pure tone frequency.

Pulse Measurement Screen

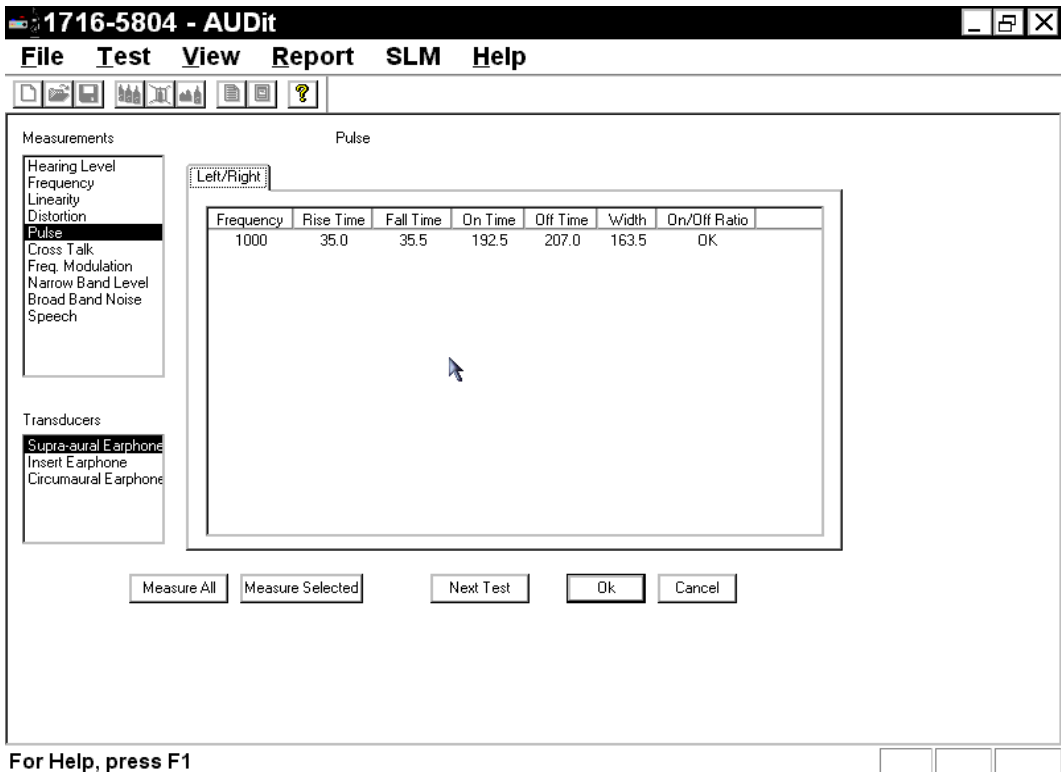


Figure 10-1 *Pulse Test measurement Screen*

To perform a pulse test from the main audiometer test status screen, highlight the **Pulse** test with the pointer and press the **Go To Measurement** button. If you are already in a test screen, press the same test in the Measurements window. Note that the SLM should be calibrated before a measurement is performed. On the left, below the measurement table (figure 10-1), the Transducers list contains supra-aural, insert and circumaural earphones. All earphones types have only one tab: Left/Right. In this example, the supra-aural earphone transducers will be calibrated. The procedure is the same for all other listed transducers.

Highlight the ***Supra-aural Earphone*** transducer list item. The Supra-aural Earphone tab will appear on the right part of the screen. The test is nominally performed on the left earphone.

The row of buttons at the bottom of the screen allows the technician to:

- Measure All - measure the pulse characteristics with software prompts
- Measure Selected - measure only the currently highlighted test with software prompts
- Next Test - move to the next measurement in the Measurements list in the upper left window
- OK - end the current test
- Cancel - cancel the current test

Press **Measure All** or highlight the first line and press Measure Selected to perform a pulse test on the left earphone. AUDit™ then displays the prompt shown in figure 10-2:

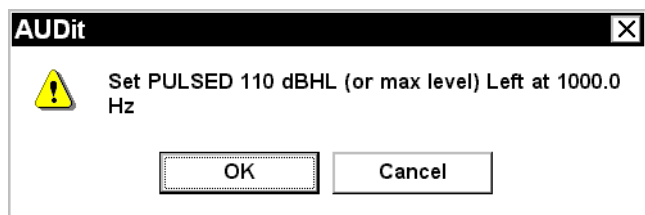


Figure 10-2 *Level and Frequency Set Dialog Box*

NOTE: *The On/Off Time limits in section 7.5.4 of ANSI S3.6-1996 are based on a 2 kHz pulse rate. If the audiometer being tested is using a different pulse rate, then the pulse on/off time measurements will likely fail. If the on/off time is the only part of the pulse test that fails, a note can be added to the certification paragraph stating that the audiometer is in compliance, with the exception of the on/off times. (See Ch 17 for instructions on modifying the certification paragraph.)*

Set the appropriate pulsed level and frequency then press **OK**. You may observe an overload on the sound level meter, in which case the level should be reduced until the overload disappears.

The results of the pulse measurement are listed in the tab (figure 10-1), in milliseconds. Values which are out of tolerance will be in parentheses, and the failed test is indicated by a large red X. Follow the same procedure to test the remaining transducers.

Cross Talk Test

Cross talk measurements performed by the AUDit™ audiometer calibration system are implemented at a chosen frequency for both earphones. Crosstalk is defined as an unwanted acoustic signal present on the channel which is not active. AUDit™ evaluates the difference between the level of the driven test earphone and the non-driven earphone (see ANSI S3.6-1996 section 5.4.2.1 item (2)).

Another test performed simultaneously in this portion of the software is the audiometer on/off ratio. This test verifies that the output from the left earphone when the tone switch is in the "OFF" position is no more than 10 dB above the reference equivalent threshold of the appropriate frequency in this case where the hearing level control is set at 80 dBHL (see ANSI S3.6-1996 section 7.5.2).

Crosstalk Measurement Screen

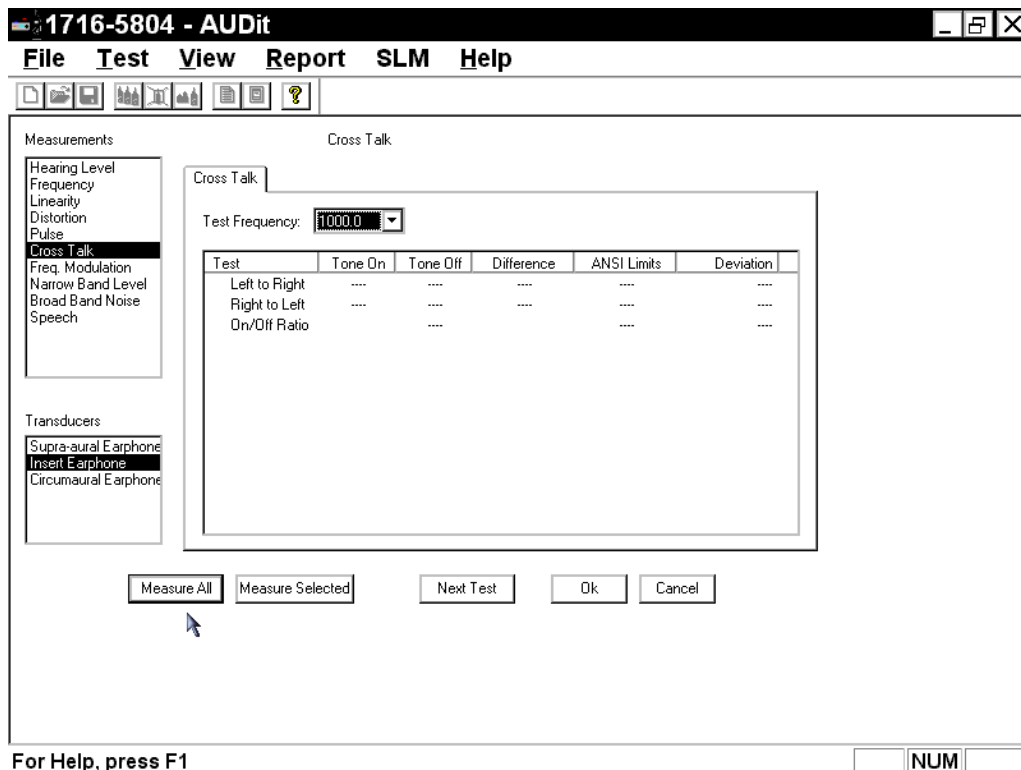


Figure 11-1 *Cross Talk Measurement Screen*

To perform a cross talk test from the main audiometer test status screen, highlight the **Cross Talk** test with the pointer and press the **Go To Measurement** button. If you are already in a test screen, press the same test in the Measurements window. Note that the SLM should be calibrated before a measurement is performed. On the left, below the measurement table (figure 11-1), the Transducers list contains supra-aural, insert and circumaural earphones. In this example, the supra-aural earphone transducers will be tested. The procedure is the same for all transducers.

Highlight the **Supra-aural Earphone** transducer list item. The Supra-aural Earphone Cross Talk tab will appear on the right part of the screen.

The row of buttons at the bottom of the screen allows the technician to:

- Measure All - perform cross talk test on both earphones and on/off ratio on the left earphone sequentially with software prompts
- Measure Selected - perform only the currently highlighted test with software prompts
- Next Test - move to the next measurement in the Measurements list in the upper left window
- OK - end the current test
- Cancel - cancel the current test

As with all measurements performed with the tone "OFF", external vibration or noise may affect the reading. The coupler and sound level meter must be on stable surfaces, preferably cushioned from room vibration. You may observe the display on the sound level meter to verify that the level is near the noise floor. Press **Measure All** to begin the cross talk test. AUDit™ displays the prompt shown in figure 11-2:

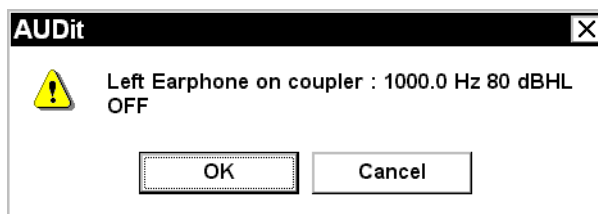


Figure 11-2 *Set Level and Frequency Set Dialog Box*

Set the appropriate level and frequency, making sure the left earphone is on the coupler and the tone is "OFF", then press **OK**. There may be a delay while the measurement system acquires a stable reading. AUDit™ should then display the prompt in figure 11-3:

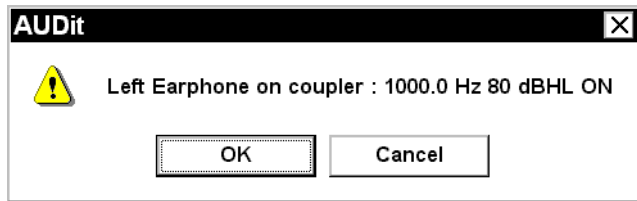


Figure 11-3 *Earphone on Coupler Dialog Box*

Present the appropriate tone on the left earphone. Once the measurement has been performed, the prompt in figure 11-4 will appear:

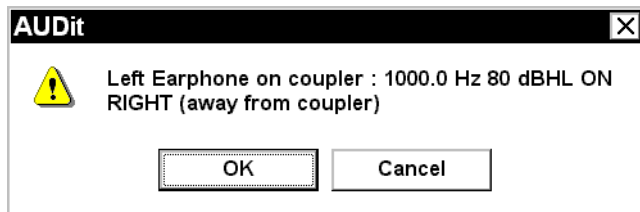


Figure 11-4 *Earphones Cross Talk Test Dialog Box*

Leave the left earphone on the coupler but present the tone on the right earphone, ensuring that it is occluded and far enough away from the coupler to prevent acoustic pickup. Figure 11-5 contains the next prompt.

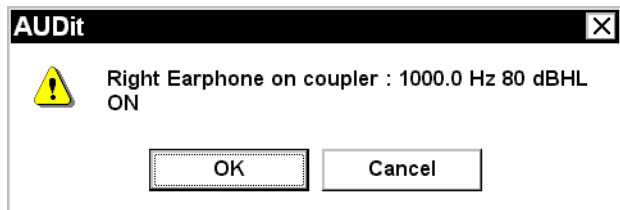


Figure 11-5 *Right Earphone on Coupler Dialog Box*

Replace the left earphone on the coupler with the right earphone. The right earphone should still be driven with the

tone. The level will once again be measured. Once this is done, the last prompt, figure 11-6, is displayed:

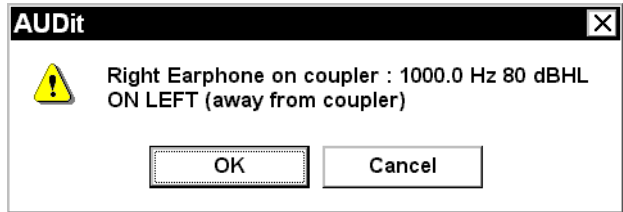


Figure 11-6 *Cross Talk Test, Right Earphone on Coupler Dialog Box*

Leave the right earphone on the coupler but present the tone on the left earphone, again ensuring that it is occluded and far enough away from the coupler to prevent acoustic cross talk.

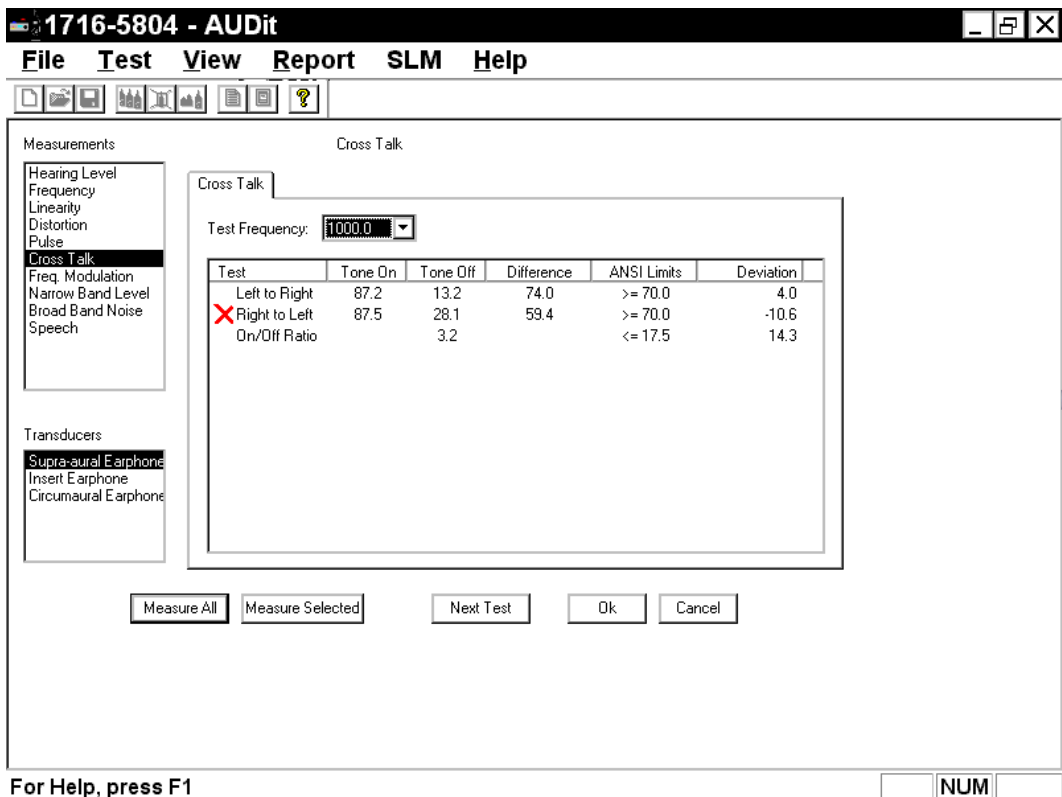


Figure 11-7 *Cross Talk Test Results Screen*

This ends the Cross Talk test. The measurements and results are displayed in the tab (Figure 11-7). For example, the first line indicates that the level with presentation in the test right earphone is 87.2 dB SPL while the level measured at the right earphone with presentation on the non-test earphone is 13.2 dB SPL. The difference of 74.0 dB is 4.0 dB greater than the specification of equal or better than 70 dB.

A subtest which is out of tolerance will be indicated by a large red X. A failed subtest may be repeated by highlighting it and pressing the Measure Selected button. Follow the same procedure to test any remaining transducers.

Frequency Modulation Test

This chapter describes the Frequency Modulation Test which verifies various parameters of the frequency modulated signals available on some audiometers. The Larson Davis audiometer calibration system performs accurate FM measurements of the pure tone signal source by using accurate period measurement techniques. The permissible values for this test are listed in section 6.1.3 of ANSI S3.6-1996. Frequency modulation parameters are measured for the available audiometer frequencies.

Frequency Modulation Measurement Screen

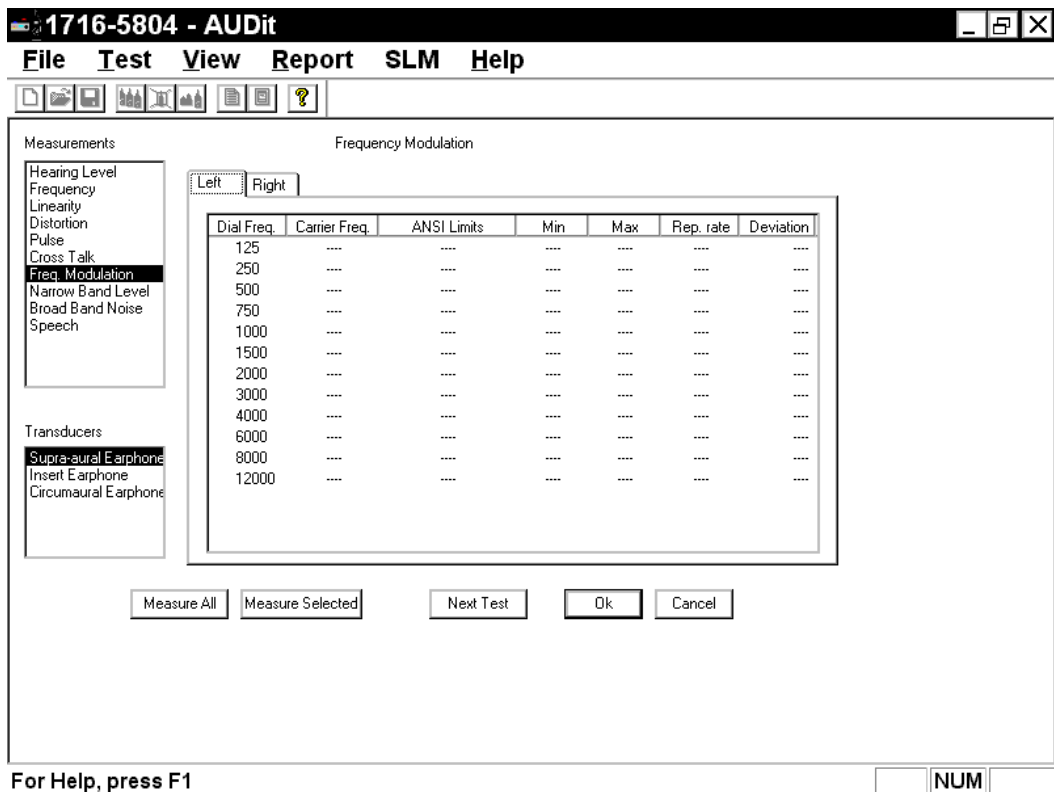


Figure 12-1 *Frequency Modulation Test Screen*

To perform a frequency modulation test from the main audiometer test status screen, highlight the ***Freq. Modulation*** test with the pointer and press the **Go To Measurement** button. If you are already in a test screen, press the same test in the Measurements table in the upper left corner. Note that the SLM should be calibrated before a measurement is performed. On the left, (figure 12-1) below the measurement table, the Transducers list contains supra-aural, insert and circumaural earphones. All earphones types have two tabs: Left and Right. In this example, the supra-aural earphone transducers will be calibrated. The procedure is the same for all transducers.

Highlight the ***Supra-aural Earphone*** transducer list item. The Frequency Modulation tabs will appear on the right part of the screen. One may select which earphone to test by pressing on the Left or Right tab.

The row of buttons at the bottom of the screen allows the technician to:

- Measure All - measure all frequencies sequentially with software prompts
- Measure Selected - measure only the currently highlighted output frequency with software prompts
- Next Test - move to the next measurement in the Measurements list in the upper left window
- OK - end the current test
- Cancel - cancel the current test

Press **Measure All** to perform a frequency modulation test on the left earphone. AUDit™ then displays the prompt shown in figure 12-2 to measure the first frequency:

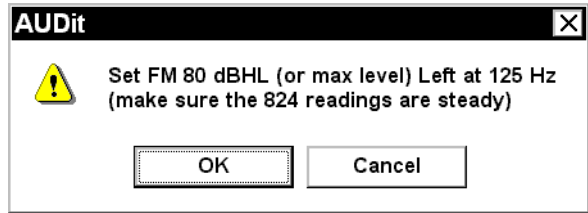


Figure 12-2 *Set Level and Frequency Dialog Box*

Set the appropriate FM stimulus level and frequency then press **OK**. There may be a delay while the measurement system acquires an average reading (figure 12-3).

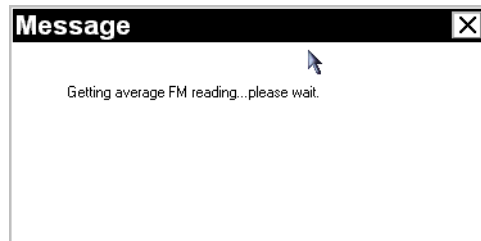


Figure 12-3 *Noise or Variation Message Window*

The presence of noise, variations in the readings or other problems may prompt the display shown in figure 12-4:

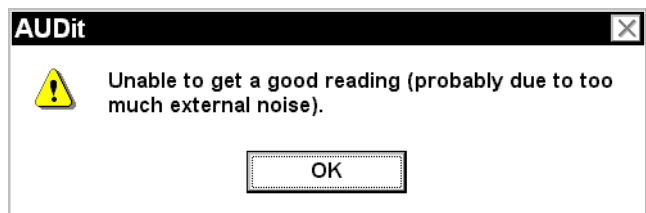


Figure 12-4 *Unable to get Reading Message Window*

It may be useful to observe the sound level meter display and change output level as needed. If the software is unable to retrieve an acceptable measurement, the frequency will be

skipped. Each frequency is tested consecutively in the same manner.

Left		Right				
Dial Freq.	Carrier Freq.	ANSI Limits	Min	Max	Rep. rate	Deviation
125	124.6	121.3 to 128.7	118.7	130.3	5.93	9.3%
250	249.3	242.5 to 257.5	238.3	260.5	5.92	8.9%
500	---	---	---	---	---	---
750	---	---	---	---	---	---
1000	---	---	---	---	---	---
1500	---	---	---	---	---	---
2000	---	---	---	---	---	---
3000	---	---	---	---	---	---
4000	---	---	---	---	---	---
6000	---	---	---	---	---	---
8000	---	---	---	---	---	---
12000	---	---	---	---	---	---

Figure 12-5 *Frequency Modulation Results Screen*

The results of the frequency modulation measurement are listed for each frequency in the tab (figure 12-5). The values are, in order:

- Dial Freq.: selected audiometric presentation frequency
- Carrier Freq.: measured carrier frequency of the modulated signal
- ANSI Limits: allowed range within 3% of the nominal frequency
- Min: minimum frequency of the FM signal
- Max: maximum frequency of the FM signal
- Rep. Rate: rate at which the FM signal is modulated in hertz (must be within 4 to 20 Hz and within 10% of the value stated in the audiometer setup screen)

- Deviation: the difference between minimum and maximum expressed in percent of the carrier frequency. It must be within 5 to 25% and within 10% of the value stated in the audiometer setup screen

Any value which is out of tolerance is displayed within parentheses. Frequencies out of tolerance are indicated by a large red X.

A failed frequency may be retested after adjustment by highlighting it and pressing the Measure Selected button. Follow the same procedure to test the remaining transducers.

Narrow Band Level Test

The Narrow Band Level Test is very similar to the Hearing Level test covered earlier. Narrow band noise is available in certain audiometers for masking and stimulus purposes. The Larson Davis audiometer calibration system performs the narrow band level measurements using real-time third octave filter analysis. Specifications regarding the masking sound level controls are enumerated in section 7 of ANSI S3.6-1996. Various requirements include the accuracy of the masking sound level, which we test here. Maximum permissible deviation from the indicated value is 3 dB below to 5 dB above the indicated level (see section 7.4.2 of the standard).

Narrow Band Level Measurement Screen

To perform a narrow band level test from the main audiometer test status screen, highlight the *Narrow Band Level* test with the pointer and press the **Go To Measurement** button. If you are already in a test screen, press the same test in the Measurements table in the upper left corner. Note that the SLM should be calibrated before a measurement is performed. On the left, below the measurement table, the Transducers list contains supra-aural, insert and circumaural earphones as well as speakers.

Narrow Band Level Test with Earphone Transducers

All earphone transducer types have four tabs in the large test window (figure 13-1) at the right: Low and High Freq. Input Levels, Left and Right. On the other hand, the speakers option has five tabs. In this section, the supra-aural earphone

transducers will be calibrated. The procedure is the same for insert and circumaural earphones.

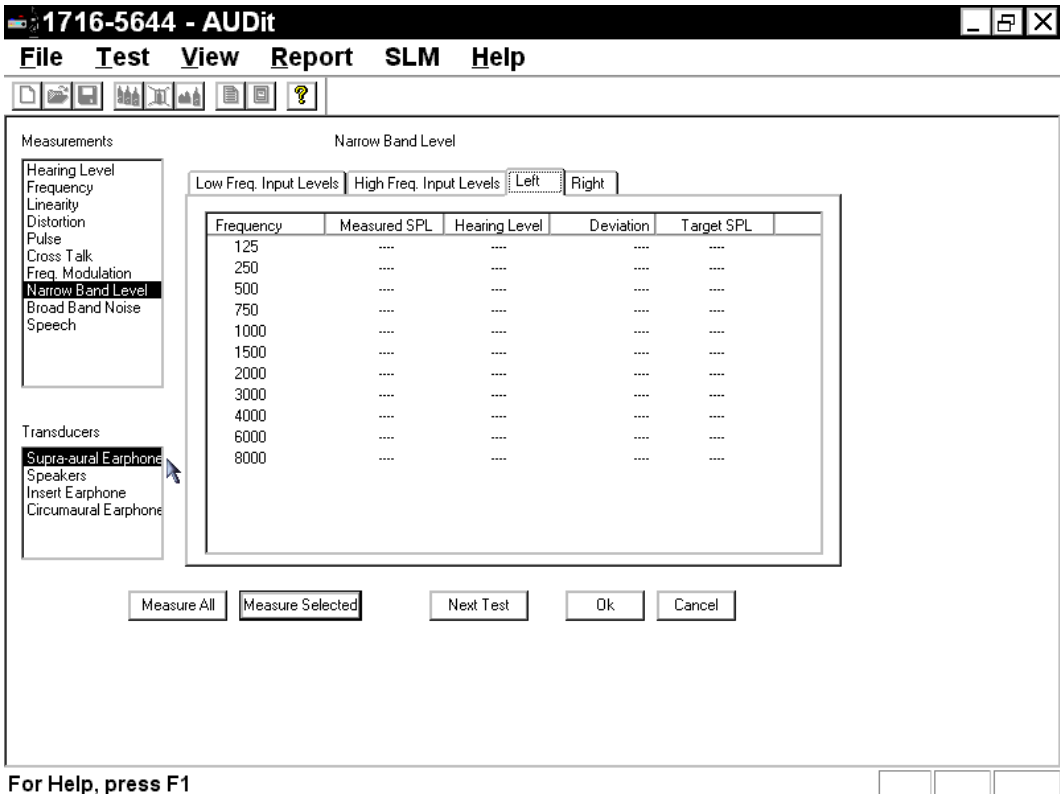


Figure 13-1 *Narrow Band Level measurement Screen*

To perform a test of the supra-aural earphones, highlight the **Supra-aural Earphone** transducer list item. The four Supra-aural Earphone Narrow Band Level tabs will appear on the right part of the screen. Default low and high frequency input levels are typically set to 70 dB HL on each tab. Each value may be changed by highlighting it and entering a new value. Use the pointer or the TAB key to move to another frequency. The levels are set to 70 dB HL for all frequencies by default.

Once the input levels have been verified, you may select which earphone to test by pressing on the Left or Right tab.

Low Freq. Input Levels		High Freq. Input Levels		Left	Right
Frequency	Measured SPL	Hearing Level	Deviation	Target SPL	
125	---	---	---	---	
250	---	---	---	---	
500	---	---	---	---	
750	---	---	---	---	
1000	---	---	---	---	
1500	---	---	---	---	
2000	---	---	---	---	
3000	---	---	---	---	
4000	---	---	---	---	
6000	---	---	---	---	
8000	---	---	---	---	

Figure 13-2 *Active Frequencies List*

The list of the active frequencies selected earlier in the audiometer setup appears in the right window (figure 13-2). Note the headers at the top of the table. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed along with the permissible target SPL range.

The row of buttons at the bottom of the screen allows the technician to:

- Measure All - measure all frequencies sequentially with software prompts
- Measure Selected - measure only the currently highlighted frequency with software prompts
- Next Test - move to the next measurement in the Measurements list in the upper left window.
- OK - end the current test
- Cancel - cancel the current test

Press **Measure All** to perform a narrow band level test on the current earphone. AUDit™ then displays the prompt shown in figure 13-3 for the first frequency:

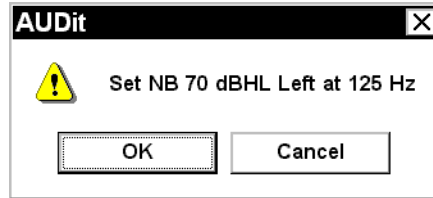


Figure 13-3 *Level and Frequency Set Dialog Box*

Set the appropriate narrow band level and frequency then press **OK**. Each frequency will be tested consecutively until all have been measured. This can be done very quickly by pressing the audiometer frequency increment button and then immediately pressing the Enter (OK) key on the computer.

Low Freq. Input Levels		High Freq. Input Levels		Left	Right
Frequency	Measured SPL	Hearing Level	Deviation	Target SPL	
125	120.6	69.1	-0.9	118.5 to 126.5	
250	100.6	70.1	0.1	97.5 to 105.5	
500	85.9	68.4	-1.6	84.5 to 92.5	
750	82.4	68.9	-1.1	80.5 to 88.5	
1000	83.0	69.5	-0.5	80.5 to 88.5	
1500	82.5	69.0	-1.0	80.5 to 88.5	
2000	86.1	69.1	-0.9	84.0 to 92.0	
3000	83.4	67.9	-2.1	82.5 to 90.5	
4000	87.4	71.9	1.9	82.5 to 90.5	
6000	88.6	70.1	0.1	85.5 to 93.5	
8000	86.7	68.7	-1.3	85.0 to 93.0	

Figure 13-4 *Narrow Band Level Test Results Screen*

In the above example (figure 13-4), all frequencies passed. Errors would be indicated by a large red X next to the frequency. After adjustment, any failed frequency may be retested with the Measure Selected button.

Narrow Band Level Test with Speakers

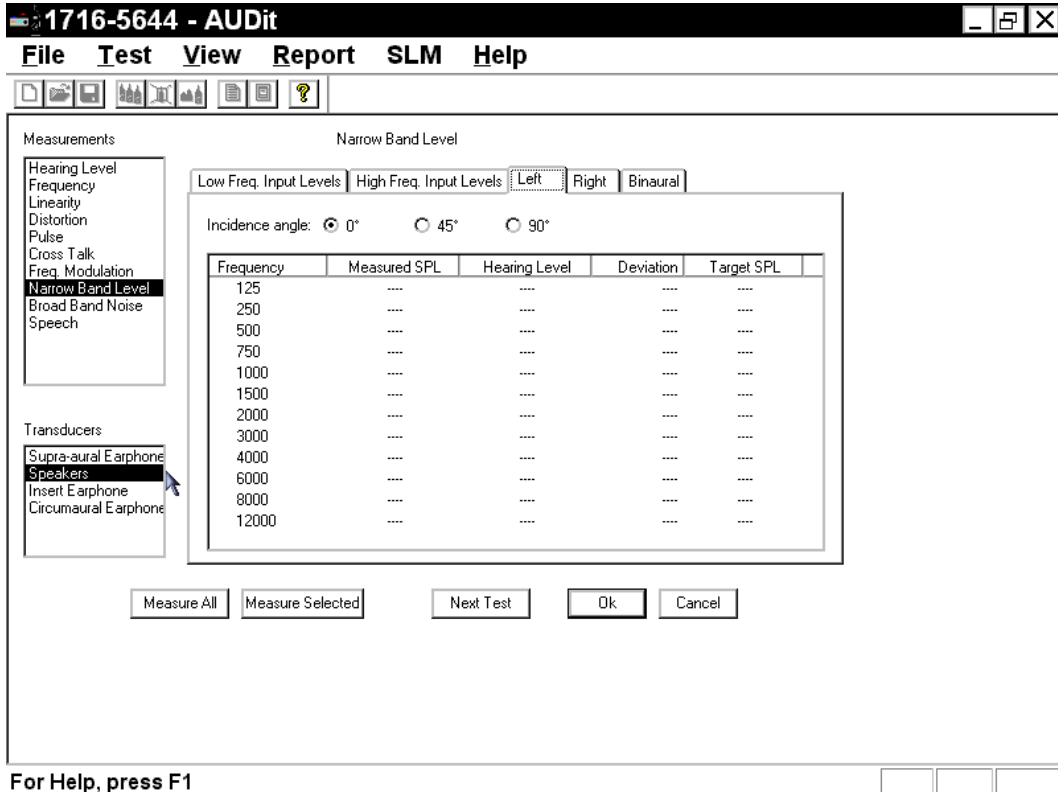


Figure 13-5 *Narrow Band Test With Speakers Screen*

Sound field audiometric testing using speakers may be performed in a variety of ways. Table 9, ANSI S3.6-1996 lists reference equivalent threshold sound pressure levels (RETSPL) for binaural listening in free field at 0 degree incidence, as well as monaural listening in sound field for 0, 45 and 90 degree incidence. These RETSPLs are used in AUDit™ to translate the measured sound pressure levels to hearing level. Note that the prescriptions in section 9.5.1 of the standard for sound field characteristics should be fol-

lowed. These include the requirement that the ambient noise in the sound field shall not exceed that specified in ANSI S3.1-1991. The ambient noise booth test in AUDit™ is helpful in making this determination.

To perform a test using speakers, highlight the ***Speakers*** transducer list item. The Narrow Band Level screen (figure 13-5) for the speakers transducers has five tabs: Low and High Freq. Input Levels, Left, Right and Binaural. In the first two tabs, the speaker test levels can be specified for audiometric frequencies from 125 to 20000 Hertz. Use the pointer or TAB key to move from one frequency to another and enter the desired test level.

The remaining tabs select the speaker(s) to be tested: left, right or both (binaural). In this example, the Left tab is selected. The incidence angle of 0, 45 or 90 degrees must be selected so that the appropriate RETSPL correction is applied. Note the headers at the top of the table. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed. The Right tab operates in the same manner. The Binaural tab has only one incidence angle selection, zero degrees.

The row of buttons at the bottom of the screen allows the technician to:

- Measure All - measure all frequencies sequentially with software prompts
- Measure Selected - measure only the currently highlighted frequency with software prompts
- Next Test - move to the next measurement in the Measurements list in the upper left window
- OK - end the current test
- Cancel - cancel the current test

Press **Measure All** to perform a narrow band level test using the speakers. Since narrow band modulation is required for this test, you will also be prompted to select a NB test signal (Figure 13-6).

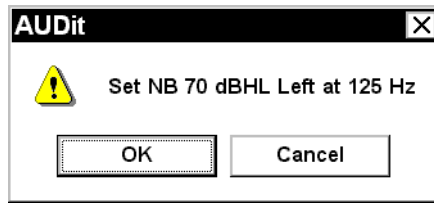


Figure 13-6 *Set Level and Frequency Dialog Box*

Set the appropriate level and frequency then press **OK**. Each frequency will be tested consecutively until all have been measured. This test can also be performed rapidly by pressing the audiometer frequency increment button and then immediately pressing the **Enter** (OK) key on the computer.

Broad Band Noise Masking Test

The Larson Davis audiometer calibration system performs accurate broad band ("white") noise masking measurements using narrow band fast fourier transform (FFT) analysis. The requirements of ANSI S3.6-1996 are listed in section 6.3.2. A minimum sound pressure spectrum flatness of within 5 dB of the level at 1000 Hz is required. The measurement is performed with an appropriate coupler.

Broad Band Masking Measurement Screen

1716-5644 - AUDit [Minimize] [Maximize] [Close]

File Test View Report SLM Help

[Icons]

Test Date: year: 1999 month: Apr day: 01

Audiometer: Grason Stadler 1716 SN:5644

Calibration Technician: Spiro Cochler

Test	Supra-aural Earphones	Bone vibrator	Speakers	Insert Earphones	Circumaural Earphones
Hearing Level	-	-	-	-	-
Frequency	-	n/a	n/a	-	-
Linearity	-	n/a	n/a	-	-
Harmonic Distortion	-	-	n/a	-	-
Pulse	-	n/a	n/a	-	-
Cross Talk	-	n/a	n/a	-	-
Frequency Modulation	Pass	n/a	n/a	-	-
Narrow Band Level	Pass	n/a	n/a	-	-
Broad Band Noise	-	n/a	n/a	-	-
Speech	-	-	-	-	n/a

Go To Measurement... Back to Setup... Done

For Help, press F1

Figure 14-1 Audiometer Measurement Status Screen

To perform a broad band noise test from the main audiometer test status screen, highlight the **Broad Band Noise** test with the pointer and press the **Go To Measurement** button (figure 14-1). If you are already in a test screen, press the same test in the Measurements window. Note that the SLM should be calibrated before a measurement is performed.

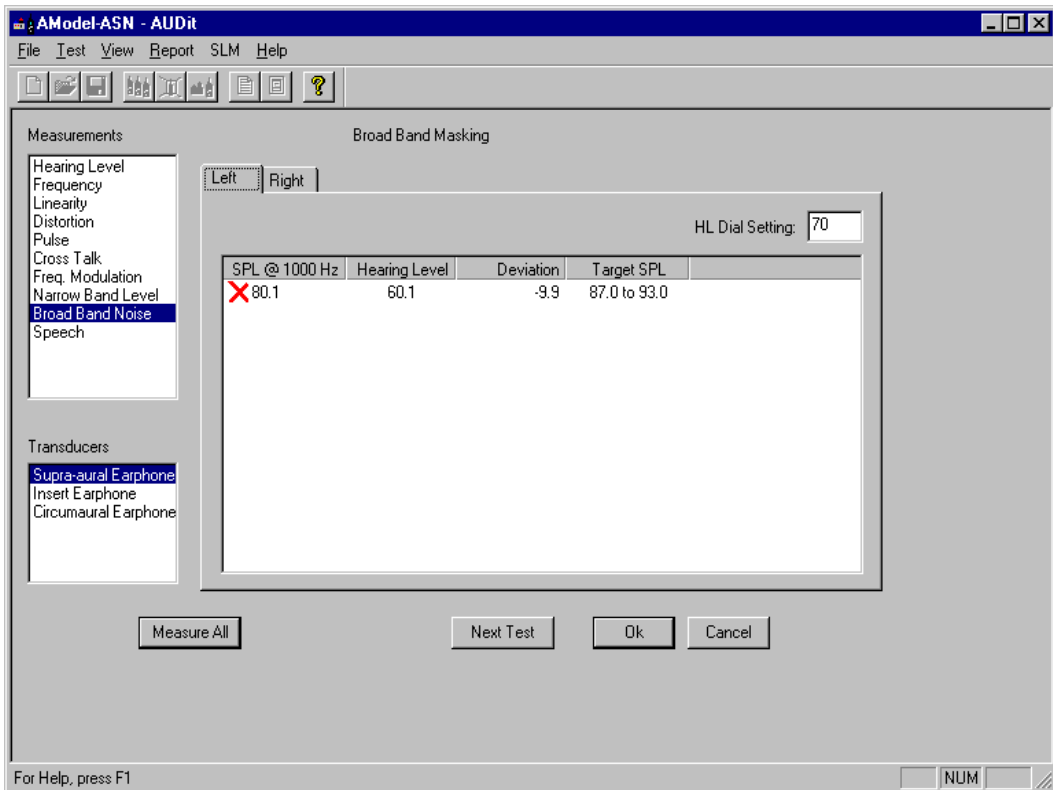


Figure 14-2 **Broad Band Masking Measurement Screen**

On the left, below the measurement table (figure 14-2), the Transducers list contains supra-aural, insert and circumaural earphones. All earphones types have two tabs: Left and Right. In this example, the supra-aural earphone transducers will be calibrated. The procedure is the same for all listed transducers.

Highlight the **Supra-aural Earphone** transducer list item. The Supra-aural Earphone tabs will appear on the right part

of the screen. One may select which earphone to test by pressing on the Left or Right tab.

The row of buttons at the bottom of the screen allows the technician to:

- Measure All - perform this test with software prompts
- Next Test - move to the next measurement in the Measurements list in the upper left window
- OK - end the current test
- Cancel - cancel the current test

In the **HL Dial Setting** enter the Hearing Level Dial Setting that you will use for the measurement. Press **Measure All** to perform a broad band masking test on the left earphone. AUDit™ then displays the prompt shown in figure 14-3:

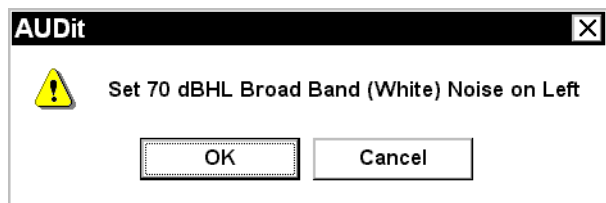


Figure 14-3 *Set Level and Frequency Dialog Box*

Set the appropriate level and frequency with white noise stimulus and then press OK.

Speech Test

This test verifies the calibration of audiometers which offer the facility for playback of standardized prepared speech signals. Speech signals may be provided from a microphone, tape or compact disc recording input electrically to the audiometer. AUDit™ performs level tests on microphone, tape/CD inputs A and B, as well as internally generated speech noise signals.

Speech Measurement Screen

1716-5644 - AUDit

File Test View Report SLM Help

Test Date: year: 1999 month: Jun day: 04

Audiometer: Grason Stadler 1716 SN:5644

Calibration Technician: Spiro Cochler

Test	Supra-aural Earphones	Bone vibrator	Speakers	Insert Earphones	Circumaural Earphones
Hearing Level	-	-	-	-	-
Frequency	-	n/a	n/a	-	-
Linearity	-	n/a	n/a	-	-
Harmonic Distortion	-	-	n/a	-	-
Pulse	-	n/a	n/a	-	-
Cross Talk	-	n/a	n/a	-	-
Frequency Modulation	Pass	n/a	n/a	-	-
Narrow Band Level	Pass	n/a	-	-	-
Broad Band Noise	Pass	n/a	n/a	-	-
Speech	-	-	-	-	n/a

Go To Measurement... Back to Setup... Done

For Help, press F1

Figure 15-1 *Audiometer Measurement Status Screen*

To perform a speech test from the main audiometer test summary screen, highlight **Speech** Test with the pointer and press the **Go To Measurement** button. If you are already in a test screen (figure 15-1), press the same test in the Measurements window. Note that the SLM should be calibrated before a measurement is performed. The Speech test can be performed with supra-aural and insert earphones, as well as with the bone vibrator and speakers. Appropriate corrections are applied within each test using microphone, coupler and standard adjustments.

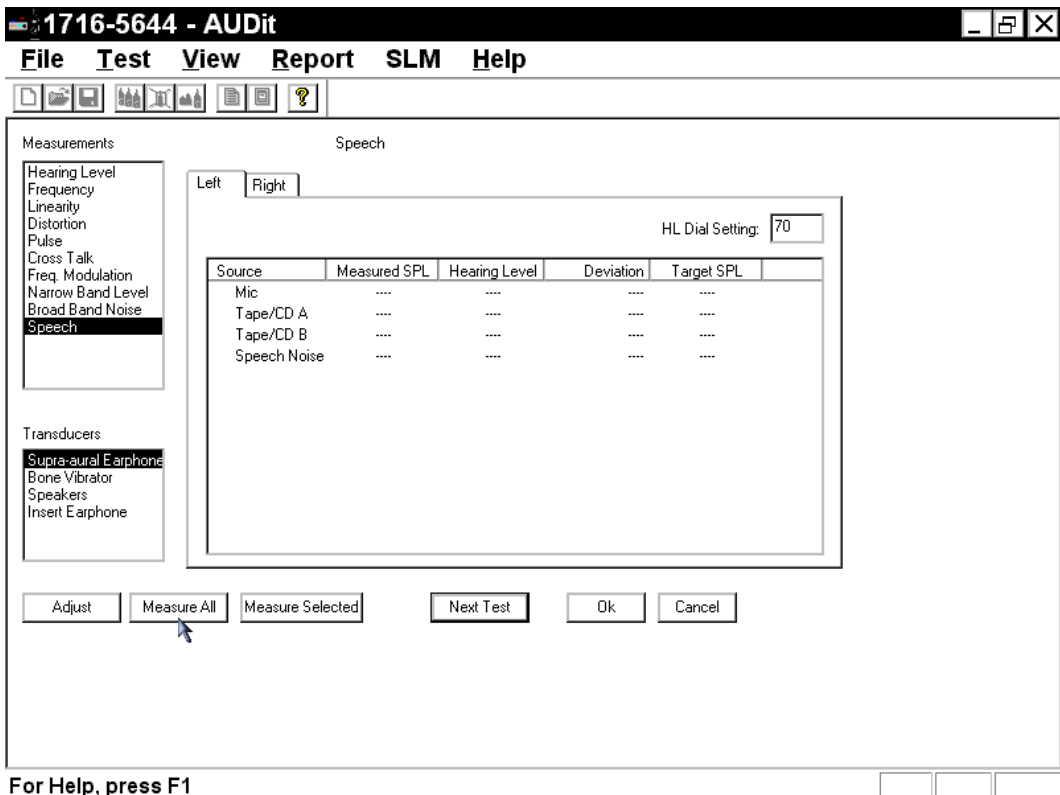


Figure 15-2 *Speech Test Transducers Screen*

On the left below the Measurements table (figure 15-2) you will find the list of transducers for which the audiometer speech facilities may be tested. The large box at the right has multiple tabs and varies with each transducer. For example, all earphones types have two tabs: Left and Right. On the other hand, the bone vibrator has only one tab: Bone Vibra-

tor. The speakers transducer test has three tabs: Left, Right and Binaural. All tests within one tab are performed with a certain HL dial setting which is displayed at the upper right of the screen.

Speech Test with Earphone Transducers

In this section, the supra-aural earphone transducers will be calibrated. The procedure is the same for insert earphones and is very similar for the other transducers.

To perform a test of the supra-aural earphones, highlight the ***Supra-aural Earphone*** transducer list item. The two Supra-aural Earphone Hearing Level tabs will appear on the right part of the screen. One may select which earphone to test by pressing on the Left or Right tab.

The list of the available tests appears in the right window:

- Mic: Audiometer microphone source selection
- Tape/CD A: Audiometer recorded tape or compact disc direct electrical source selection A
- Tape/CD B: Audiometer recorded tape or compact disc direct electrical source selection B
- Speech Noise: Speech noise source selection

NOTE: *The headers at the top of the table. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed.*

The desired test hearing level is selected at the upper right of the tab, in the HL Dial Setting field.

The row of buttons at the bottom of the screen allows the technician to:

- Adjust - adjust the audiometer in real-time if a precision output level adjustment is available
- Measure All - measure all subtests sequentially with software prompts
- Measure Selected - measure only the currently highlighted subtest with software prompts
- Next Test - move to the next measurement in the Measurements list in the upper left window
- OK - end the current test

- Cancel - cancel the current test

Mic Test

Press **Measure All** to perform a complete speech level test on the left earphone, or highlight the Mic line and press **Measure Selected**. AUDit™ then displays the prompt shown in figure 15-3:

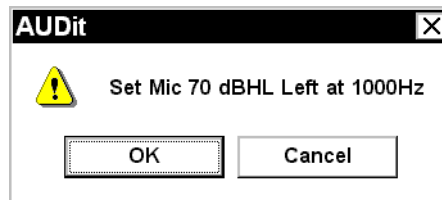


Figure 15-3 *Set Level and Frequency Dialog Box*

The speech material calibration signal should be provided at the microphone input. Set the appropriate level, input and presentation on the audiometer then press OK. The measured SPL is corrected for coupler, microphone and other responses and should be 12.5 dB above the 1000 Hz RETSPL for the transducer in use (See ANSI S3.6-1996 section 6.2.12.). Target SPL is determined from ANSI S3.6 section 7.2 on the accuracy of sound pressure levels. An unsatisfactory reading is indicated by a large red X.

It may be necessary to adjust the level by pressing the Adjust button.

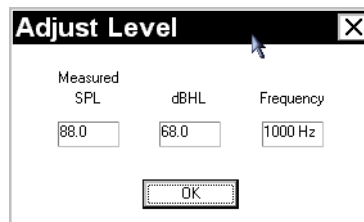


Figure 15-4 *Current Level Readings Screen*

A small dialog box appears (figure 15-4) which shows the current SPL and HL readings which the technician may adjust to bring the level within the listed target SPL range. The adjustment does not affect the test result performed before.

To verify the adjustment, the input may be retested with the **Measure Selected** button.

Tape/CD A and Tape/CD B Test

To perform a speech level test on the left earphone Tape/CD A or B inputs, highlight the appropriate subtest and press **Measure Selected**. AUDit™ then displays the prompt shown in figure 15-5:

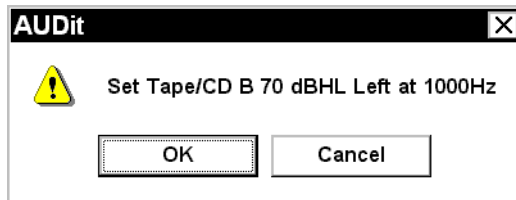


Figure 15-5 *Set Tape Level and Frequency Dialog Box*

The speech material calibration signal should be provided to the appropriate input. Set the listed level, input and presentation on the audiometer then press OK. The measured SPL is corrected for coupler, microphone and other responses and should be 12.5 dB above the 1000 Hz RETSPL for the transducer in use. (See ANSI S3.6-1996 section 6.2.12.) Target SPL is determined from ANSI S3.6 section 7.2 on the accuracy of sound pressure levels. An unsatisfactory reading is indicated by a large red X.

It may be necessary to adjust the level by pressing the Adjust button.

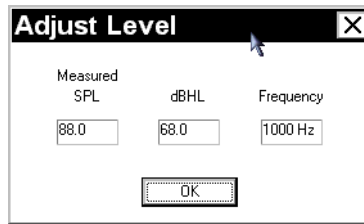


Figure 15-6 *Current Level Readings Screen*

A small dialog box appears (figure 15-6) showing the current SPL and HL readings which one can adjust to bring the level within the listed target SPL range.

Once this is done, the input may be retested with the **Measure Selected** button.

Speech Noise Test

To perform a speech noise level test on the left earphone, highlight the last subtest and press **Measure Selected**. AUDit™ then displays the prompt shown in figure 15-7:

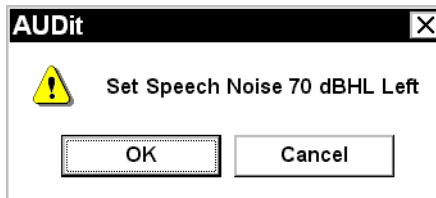


Figure 15-7 *Speech Noise Level Set Dialog Box*

The speech material calibration signal should be provided to the appropriate input. Set the listed level, input and presentation on the audiometer and press OK. The measured SPL is corrected for coupler, microphone and other responses. An unsatisfactory reading is indicated by a large red X.

It may be necessary to adjust the level by pressing the Adjust button.

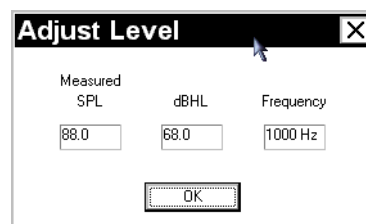


Figure 15-8 *Current Level Readings Screen*

A small dialog box appears (figure 15-8) which shows the current SPL and HL readings which one can adjust to bring the level within the listed target SPL range.

Once this is done, the input may be retested with the Measure Selected button.

Speech Test with Bone Vibrator

Bone Vibrator

Placement: ☒ Mastoid ☐ Forehead

HL Dial Setting:

Source	Measured SPL	Hearing Level	Deviation	Target SPL	
Mic	---	---	---	---	
Tape/CD A	---	---	---	---	
Tape/CD B	---	---	---	---	
Speech Noise	---	---	---	---	

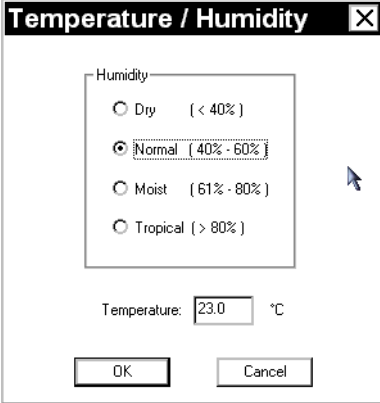
Figure 15-9 *Bone Vibrator Test Screen*

To perform a test of the bone vibrator transducer, highlight the **Bone Vibrator** transducer list item. The Speech screen for the bone vibrator transducer has a single tab: Bone Vibrator (figure 15-9). It displays calibration results similar to the earphones tab, but contains a selection item for the placement of the vibrator: mastoid or forehead. The default output level is also present at the upper right hand side. Note the headers at the top of the table. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed.

The functions of the row of buttons at the bottom of the screen are the same as in the earphones speech test described earlier.

Press **Measure All** to perform all speech tests on the bone vibrator. If you are using a Larson Davis Mastoid, you will be prompted to enter temperature and humidity values used

within the software for artificial mastoid corrections (figure 15-10).

A screenshot of a software dialog box titled "Temperature / Humidity" with a close button (X) in the top right corner. Inside the dialog, there is a section labeled "Humidity" containing four radio button options: "Dry (< 40%)", "Normal (40% - 60%)", "Moist (61% - 80%)", and "Tropical (> 80%)". The "Normal" option is selected, indicated by a filled radio button. Below the humidity options, there is a text input field labeled "Temperature:" containing the value "23.0", followed by a unit label "°C". At the bottom of the dialog are two buttons: "OK" and "Cancel".

Temperature / Humidity

Humidity

☐ Dry (< 40%)

☒ Normal (40% - 60%)

☐ Moist (61% - 80%)

☐ Tropical (> 80%)

Temperature: 23.0 °C

OK Cancel

Figure 15-10 *Temperature and Humidity Entry Box*

Enter the humidity range, dry, normal, moist or tropical, as well as the temperature in degrees centigrade

Hint: (*degrees C = (degrees F - 32) x 5 / 9*).

Otherwise, the bone vibrator tests are similar to the earphone speech tests. An unsatisfactory reading is indicated by a large red X, with values within parentheses.

Speech Test with Speakers

Left Right Binaural

Incidence Angle: ☒ 0° ☐ 45° ☐ 90°

HL Dial Setting: 70

Source	Measured SPL	Hearing Level	Deviation	Target SPL
Mic	---	---	---	---
Tape/CD A	---	---	---	---
Tape/CD B	---	---	---	---
Speech Noise	---	---	---	---

Figure 15-11 *Speaker Test Screen*

Sound field audiometric testing using speakers may be performed in a variety of ways. In table 9, ANSI S3.6-1996 lists reference equivalent threshold sound pressure levels (RETSPL) for binaural listening in free field at 0 degree incidence, as well as monaural listening in sound field for 0, 45 and 90 degree incidence. These RETSPLs are used in AUDit™ to translate the measured sound pressure levels to hearing level. Note that the prescriptions in section 9.5.1 of the standard for sound field characteristics should be followed. These include the requirement that the ambient noise in the sound field shall not exceed that specified in ANSI S3.1-1991. The ambient noise booth test in AUDit™ is helpful in making this determination.

To perform a test using speakers, highlight the **Speakers** transducer list item. The Speech measurement screen for the speakers transducers has three tabs: Left, Right and Binaural (figure 15-11). These tabs select the speaker(s) to be tested:

left, right or both (binaural). In this example, the Left tab is selected. An incidence angle of 0, 45 or 90 degrees must be chosen so that the appropriate RETSPL correction is applied. Note the headers at the top of the table. The measured SPL value from the sound level meter is converted to hearing level, and the deviation from the target SPL is displayed. The Right tab operates in exactly the same manner. The Binaural tab has only one incidence angle selection, zero degrees.

The functions of the row of buttons at the bottom of the screen are the same as in the earphones speech test described above.

Press **Measure All** to perform all speech tests on the selected speaker(s). They are similar to the earphone speech tests. An unsatisfactory reading is indicated by a large red X, with values within parentheses.

Audiometer Test Notes

Before and during the calibration of an audiometer, a visual inspection of its components and control is necessary. AUDit™'s Audiometer Test Notes screen (figure 16-1) affords a simple way to annotate the test report with comments and the condition of components or controls.

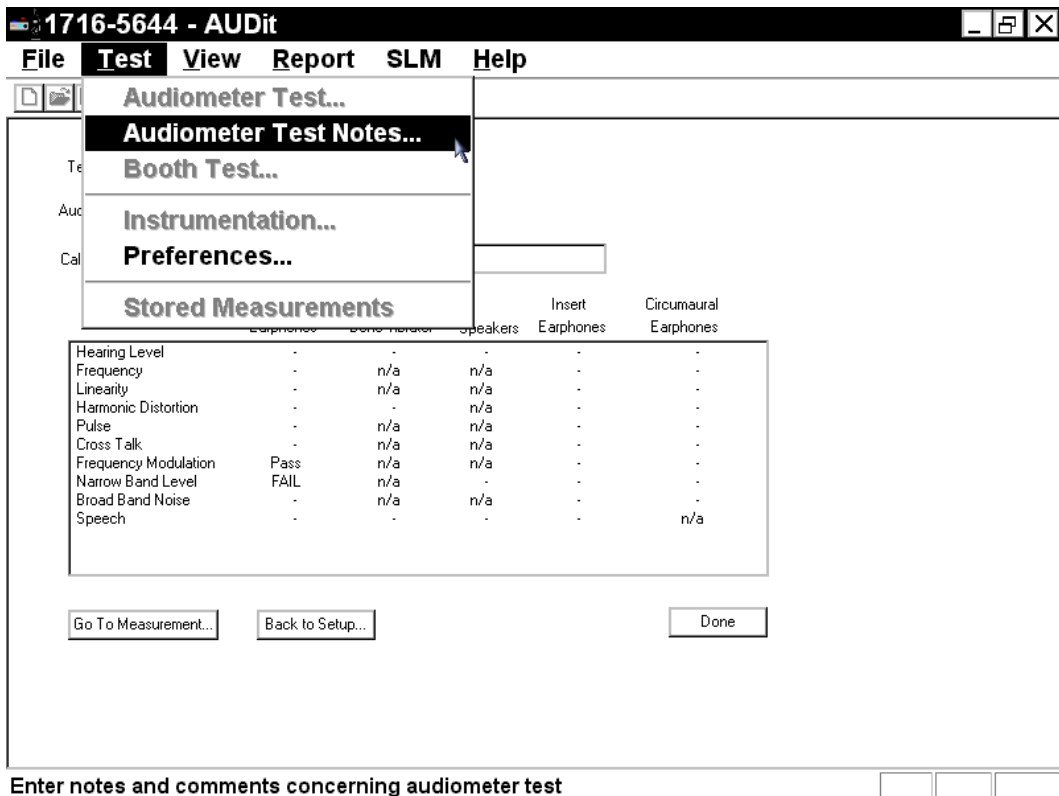


Figure 16-1 *Audiometer Test Notes Menu item*

The Audiometer Test Notes screen is accessed from the main menu by pressing the Test, **Audiometer Test Notes...** selection.

Audiometer Test Notes Screen

This screen has two tabs, *Visual Check* and *Comments*. A thorough visual and functional inspection of the audiometer and its accessories can be conducted with the help of the checklist in the first tab (Figure 16-2).

Visual Check Tab

Visual Check		Comments
☐ Left earphone	☐ Tone 'On' lamp	☐ Earphone selector switch
☐ Right earphone	☐ Power 'On' lamp	☐ Response cord
☐ Left earphone cushion	☐ Attenuator	☐ Output selector switch
☐ Right earphone cushion	☐ Masking control	☐ Ch. 1 input selector switch
☐ Left earphone cord	☐ Volume control	☐ Ch. 2 input selector switch
☐ Right earphone cord	☐ Power switch	☐ Function selector switch
☐ Headband	☐ Fuse	☐ Microphone
☐ Bone vibrator	☐ Tone interrupter	☐ Monitor earphone/speaker
☐ Bone vibrator cord	☐ Tone reverse switch	☐ Manual pulse tone control
☐ Power cord	☐ Freq. selector switch	☐ VU meter
☒ = Failed		

Figure 16-2 *Audiometer Test Notes Visual Check Tab*

This tab enumerates many components, accessories and controls of the audiometer. Some list items have properties which are governed by specifications in the ANSI S3.6-1996 standard. Any non-conforming or defective item should be checked by clicking the pointer on the box to the left of the item. These items will appear in the test report and will be stored in the database.

Comments Tab

The second tab allows the calibration technician to note any particularities of the tested system. Click in the rectangular entry field and enter your comments. Use the arrows or pointer to scroll within the entry field. Standard Windows™ edit commands are available. These comments also will appear in the test report and will be stored in the database.

Reports and Data Base Functions

AUDit™ incorporates a number of features which help maintain a record of audiometer calibrations. Tests performed can be printed immediately or stored for future hard copy. Results may be kept in an indexed database with comprehensive search capabilities, or exported to your external application in formatted output. This chapter will further describe these functions of the AUDit™ software.

Printing a Report

A printed report of a specific test may be output to a printer for archival or customer use. Both audiometer calibrations and booth measurements can be printed. An audiometer test can be printed in its entirety or only a subset of the measurements can be output.

To begin printing, a recent or recalled test must be active on the AUDit™ main screen. To recall a previous test, follow the procedures outlined later in this chapter. Once an AUDit™ test is active, click on ***Report, Report...*** on the main menu (figure 17-1).

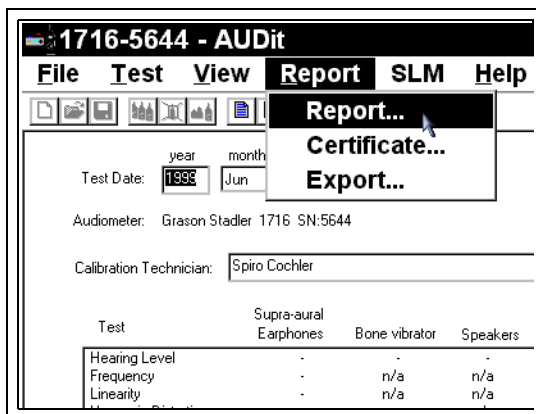


Figure 17-1 *Main Menu Report Pull Down Menu*

If the active measurement is an audiometer measurement, the dialog box shown in figure 17-2 will appear:

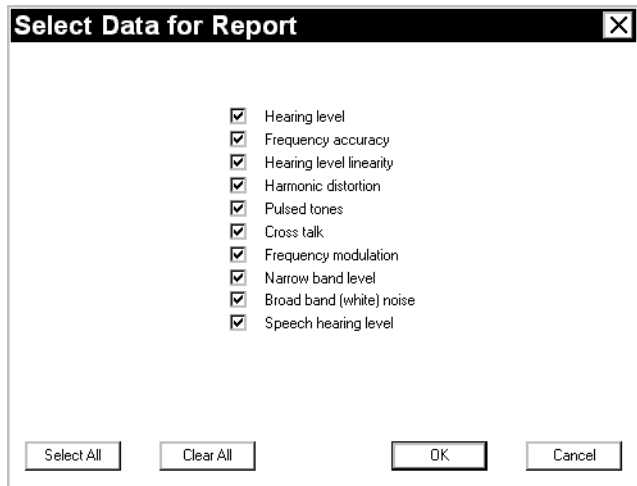


Figure 17-2 *Measurement Report Select Box*

Click on the desired subset of measurements. Press on **Select All** to enable printout of all test data, or **Clear All** to disable all tests. **OK** accepts the currently enabled selections and **Cancel** aborts the report.

Once you have selected **OK**, the report preview screen displays the selected data approximately as it will appear on the printed page (Figure 17-3). The paper size and orientation are those selected in the *File, Printer Setup...* main menu item.

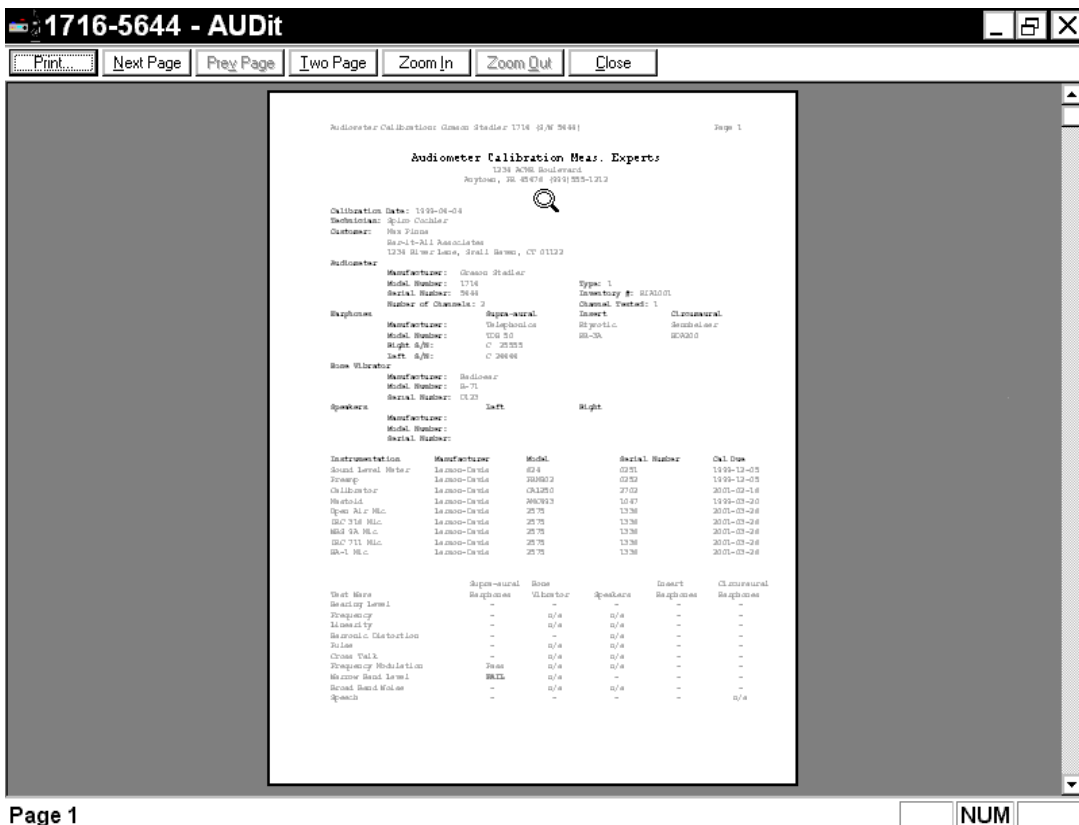


Figure 17-3 *Print Preview Screen*

Note that the cursor now has the shape of a small magnifying glass, and may be used to zoom in on portions of the page. The menu bar at the top of the screen (figure 17-4) has the following functions:

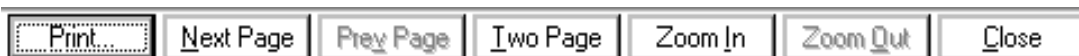


Figure 17-4 *Print Preview Tool Bar*

- **Print:** click or press **Alt + p** to go to the Print dialog box
- **Next Page:** click or press **Alt + n** to advance one page

- Previous Page: click or press **Alt + v** to go back one page
- Two Page: click or press **Alt + t** to view two pages at once
- Zoom In: click or press **Alt + i** to zoom in
- Zoom Out: click or press **Alt + o** to zoom out
- Close: click or press **Alt + c** to exit the print preview screen

Using the zoom, the information is visible on screen (figure 17-5).

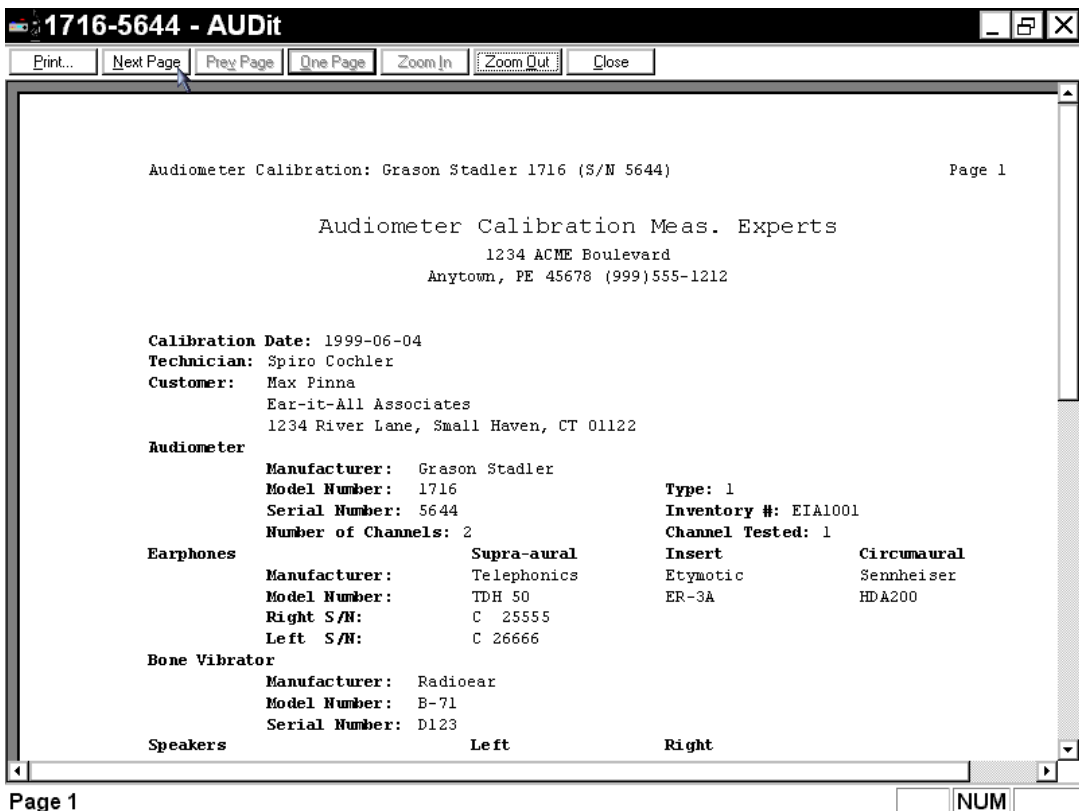


Figure 17-5 *Sample Report, Zoomed in*

For example, this report lists calibration date, technician, customer, the audiometer and accessories tested, etc. It is not

possible to edit information directly in the print preview screen.

To print the report from the preview, simply click **Print...** or press **Alt + p** to go to the Print dialog box.

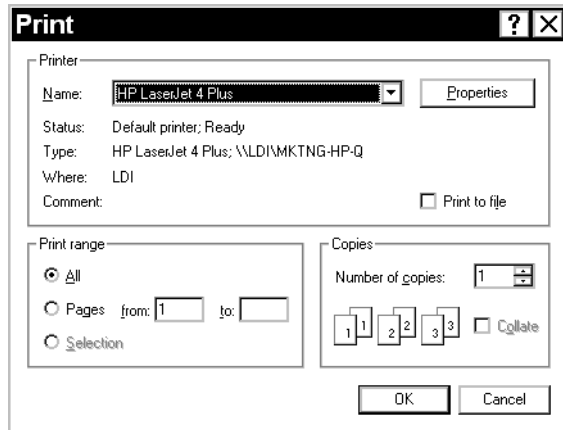


Figure 17-6 *Print Dialog Box*

This standard printing dialog box (figure 17-6) allows the selection of printer and properties, print range, as well as number of copies. After proper selection of printing options, press **OK** to print or **Cancel** to exit without printing the report.

Printing a booth test report is very similar, except that there is no Select Data for Report dialog box. All booth test data is printed.

Sample reports are appended at the end of this manual.

Printing a Certificate

It is often desirable to provide a customer with a single page certificate after performing an audiometer calibration or booth test service. AUDit™ features certificate printing, including a custom header and a paragraph which can be used for standard or test specific text. The certificate

includes the date on which the test was performed as well as the print-out date.

To print a certificate, ensure a new or recalled test is active, then select **Report, Certificate...** on the main menu bar (Figure 17-7).

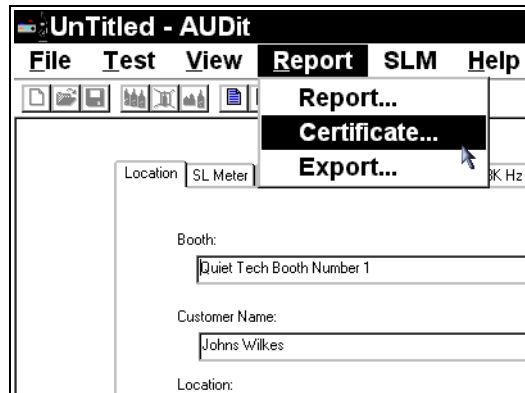


Figure 17-7 *Main Menu, Certificate Pull Down Menu item*

The Certification Paragraph dialog box is then displayed. The features of the certification paragraph are explained fully in the next section.

Certification Paragraph Dialog

The certification paragraph is a small unformatted text file which may contain any text you wish to have appear on the certificate. The Certification Paragraph dialog box allows the retrieval and modification of a previously saved paragraph as well as the creation of a new paragraph. In the example in figure 17-8, the paragraph includes the calibration entity name and text referring to the standard. Other comments may be included, such as calibration status of the equipment used to calibrate the audiometer.

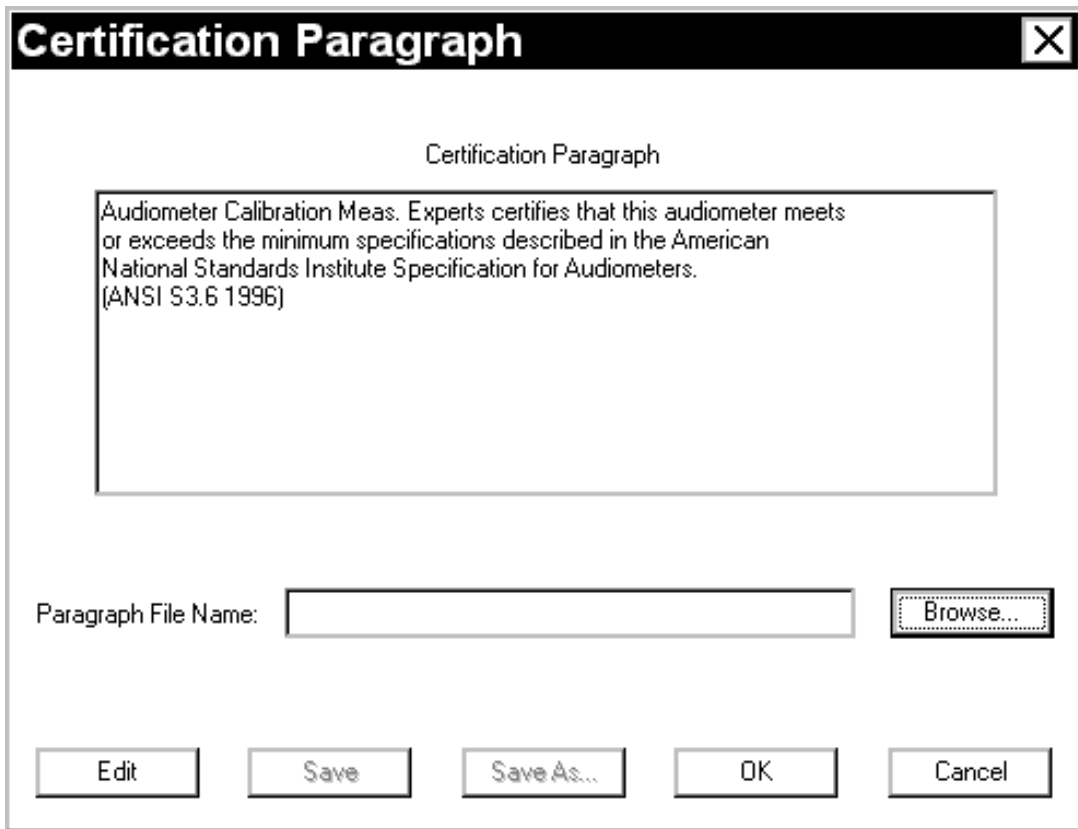


Figure 17-8 *Certification Paragraph Dialog Box*

Creating or Editing a Certification Paragraph

To create a new certification paragraph or edit the current paragraph, click on **Edit**. You may then position the cursor in the large rectangle (figure 17-8) and start editing the text. Standard numeric and alphabetical characters are allowed, but no formatting is saved. Press Enter to insert a line feed at the end of each line near the right edge of the input rectangle to limit lines to a printable length.

Once you are done editing, save the paragraph under the same name by clicking on **Save**, or change file name or

location by clicking on **Save As....** Certification paragraphs can only be stored with the .acp extension. Press **Cancel** to abort any changes, or **OK** to accept and exit to the Certificate Preview Screen.

Browsing for a Certification Paragraph

To find a previously saved paragraph, click on the **Browse...** key.

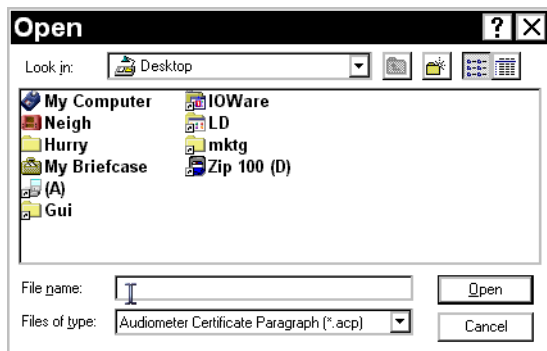


Figure 17-9 *Search for Certification Dialog Browse Box*

Calibration paragraph files ending in the .acp extension will be displayed for the current directory (figure 17-9). The Open dialog box will allow you to locate a paragraph using the standard interface. Locate the appropriate directory using the pointer, then select a paragraph and click **Open**. The selected paragraph will now be displayed in the Edit rectangle. You may then edit the paragraph, press **Cancel** to abort any changes, or **OK** to accept and exit to the Certificate Preview Screen.

Certificate Preview Screen

After creating, recalling or editing a certification paragraph, selecting **OK** will display the certificate preview.

1716-5644 - AUDIt

Print...

Next Page

Prev Page

Two Page

Zoom In

Zoom Out

Close

Right S/N: C 25555

Left S/N: C 26666

Bone Vibrator

Manufacturer: Radiostar

Model Number: B-71

Serial Number: DL22

Speakers

Left

Right

Manufacturer:

Model Number:

Serial Number:

Instrumentation	Manufacturer	Model	Serial Number	Cal Due
Sound Level Meter	Larson-Davis	824	0251	1999-12-05
Preamp	Larson-Davis	PRM902	0252	1999-12-05
Open Air Mic	Larson-Davis	2575	1338	2001-02-28
IEC 218 Mic	Larson-Davis	2575	1338	2001-02-28
M83 9A Mic	Larson-Davis	2575	1338	2001-02-28
IEC 711 Mic	Larson-Davis	2575	1338	2001-02-28
M6-1 Mic	Larson-Davis	2575	1338	2001-02-28
Calibrator	Larson-Davis	CAL250	2702	2001-02-28
Mastoid	Larson-Davis	AMC432	1047	1999-02-20

Audiometer Calibration Measurements: Experts certify that this audiometric equipment has been tested in accordance with relevant paragraphs of ANSI S3.6-1996 Specification for audiometers and has been found to meet or exceed specifications for the tests reported herein.

Test equipment is certified traceable to NIST. Calibration data is on file and may be supplied upon request.

Signature: _____

Date Issued: 1999-06-10

Spiro Cochler

Page 1

NUM

Figure 17-10 *Certificate Paragraph Print Preview*

In this screen (figure 17-9), a representation of the certificate of calibration is displayed. Note that the cursor now has the shape of a small magnifying glass, and may be used to zoom in on portions of the page. The menu bar at the top of the screen has the following functions:

- Print: click or press **Alt + p** to go to the Print dialog box
- Zoom In: click or press **Alt + i** to zoom in
- Zoom Out: click or press **Alt + o** to zoom out
- Close: click or press **Alt + c** to exit the certificate preview screen

Exporting Data

Audiometer and booth test data are maintained in a special database by AUDit™. You may wish to export the results of a certain test to another application for further manipulation. This is possible with the Export function. To export test data, ensure a new or recalled test is active, then select **Report, Export...** on the main menu bar (Figure 17-10).

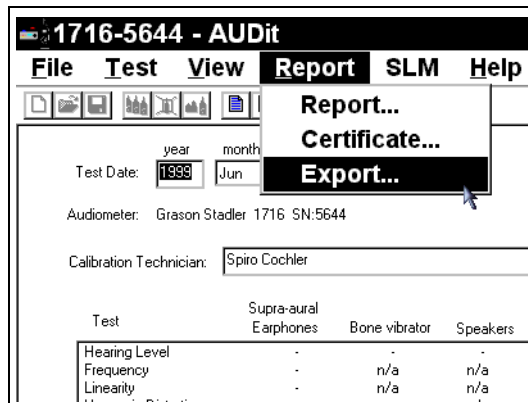


Figure 17-11 *Export Data Main Menu Pull Down Menu*

Hint: *.csv files have a standard comma separated format.*

The Export Data dialog box (figure 17-12) will be displayed. In this dialog, the file name of the exported file and the application used to open it may be selected. If you wish to export to a previously stored file name, the older file will be replaced. Use the Browse to find a previous name and location. It is possible to browse for .csv, .txt and all files. However, files may only be stored with the .csv extension.

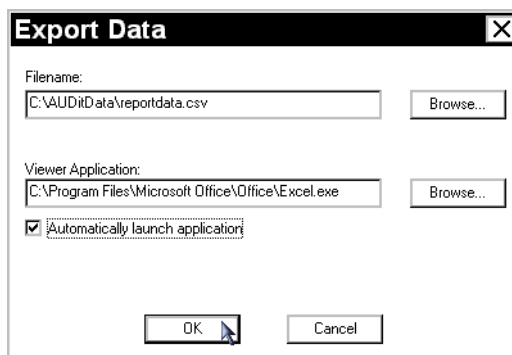


Figure 17-12 *Export Data Dialog Box*

As an example, an audiometer test file may be exported to .csv format and then formatted with Microsoft Excel™ to add graphs and tables for greater impact.

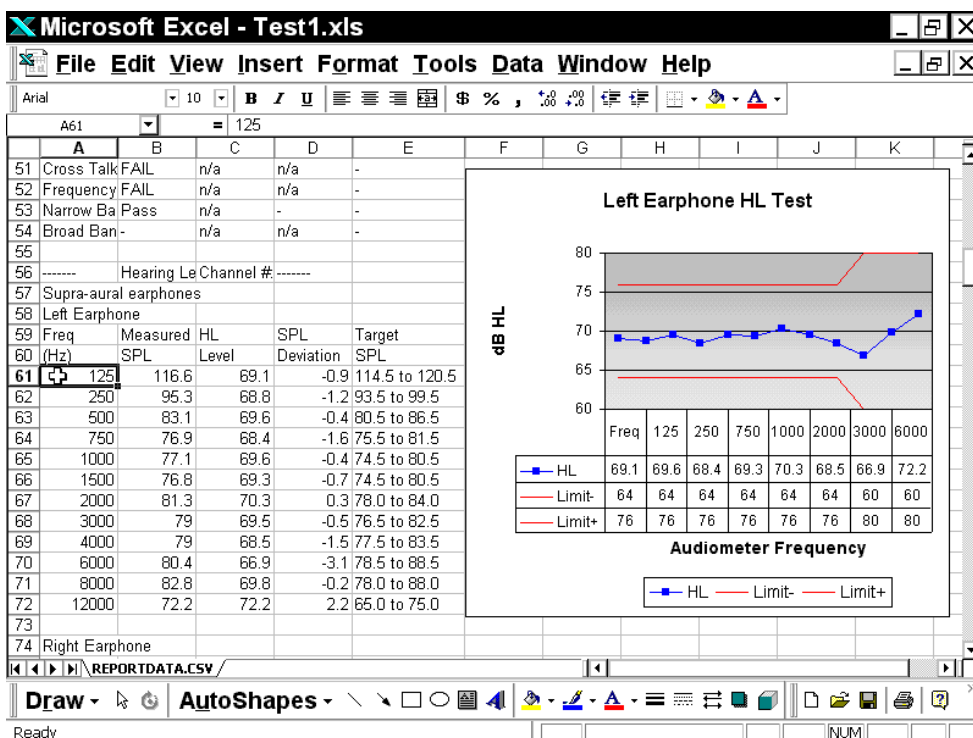


Figure 17-13 *Data File Exported into Microsoft Excel™*

Stored Measurements Database Functions

The Larson Davis audiometer calibration system software maintains all tests, audiometer and booth, in a database which is compatible with state of the art database software. This section will illustrate the use of the database to retrieve booth and audiometer measurements.

To recall a stored measurement, click on the ***Test, Stored Measurements*** item on the main menu bar (figure 17-14).

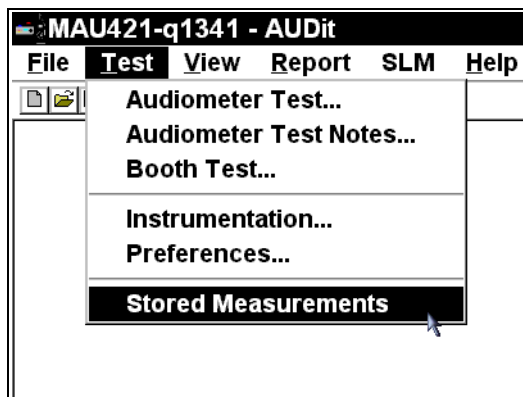


Figure 17-14 *Test Pull Down Menu, Stored Measurements items*

The Stored Measurements dialog box will appear. This box allows the search and display of tests which fulfill the search requirements.

Audiometer Measurements

The audiometer measurements available in the current AUDit™ database can be searched with the dialog box shown in figure 17-15.

Stored Measurements

Audiometric Measurements Booth Test Data

Search database by entering a Technician name, Audiometer Model, Audiometer Serial number and/or a date

List all tests in the database by leaving the edit fields blank.

Technician:

Model:

Serial Num:

From Date:

To Date:

Channel:

Update List

Technician	Model	Serial Num	Channel	Date
asdfasd	1716	5804	1	Apr. 20, 1999
Spiro Cochler	1716	5644	1	Jun. 04, 1999
Eustache Toobs	WEW1000	SA1872	1	Feb. 07, 1999
Herschell Harecel	MAU421	q1341	1	Jun. 10, 1999

Retrieve

Delete

Cancel

Figure 17-15 *Search Database Dialog Box*

Entry fields for technician, audiometer model, serial number, calibration from/to date and channel number can be used to search for the proper test. When all fields are left blank, all tests in the current database are displayed. To find a certain test, enter a search criterion in a field. Alphabetical characters are not case sensitive in the search, but otherwise search entries must be spelled exactly as they appear in the test. Spaces before or after an entry are disregarded. Dates may be entered in the following formats: "Apr. 20, 1999" or "04/20/99". The **To Date** must be equal to or later than the **From Date**.

Click on **Update List** to display the search results. In the example above, entering "spiro COchler" in the **technician** field will display the second test on the list. Retrieve the test

by highlighting it and then clicking on **Retrieve** at the bottom of the dialog box. Delete the highlighted test by clicking on **Delete**. Deleted tests can not be recalled.

Booth Test Data

The booth measurements available in the current AUDit™ database can be searched with the dialog box shown in figure 17-16.

Stored Measurements [X]

Audiometric Measurements **Booth Test Data**

Enter customer name, booth name and/or dates to filter measurement selections.
Or leave blank for a list of all booth measurements.

Customer: Booth Name:

From Date: To Date:

Test Name	Customer	Booth	Date
LarsonDavisBooth1	Jeff Cohen	Larson Davis Audiomet...	Jun. 10, 1999
LarsonDavisBooth2	Larson Davis Laborato...	Booth 1	Jun. 10, 1999
BasilCorti	Basil Corti	Kwayet Technologies	Jun. 10, 1999
BasilCorti2	Basil Corti	Kwayet Technologies ...	Jun. 10, 1999
PHOWenBooth1	P. H. Owen	Quiet Tech Number 1	Jun. 17, 1999

Figure 17-16 *Search Booth Measurements Dialog Box*

Entry fields for customer, booth name, calibration from/to date and channel number can be used to search for the proper test. When all fields are left blank, all tests in the current database are displayed. To find a certain test, enter a

search criterion in a field. Alphabetical characters are not case sensitive in the search, but otherwise search entries must be spelled exactly as they appear in the test. Spaces before or after an entry are disregarded. Dates may be entered in the following formats: "Apr. 20, 1999" or "04/20/99". The ***To Date*** must be equal to or later than the ***From Date***.

Click on **Update List** to display the search results. Retrieve the test by highlighting it and then clicking on **Retrieve** at the bottom of the dialog box. Delete the highlighted test by clicking on **Delete**. Deleted tests can not be recalled.

824-AUD Firmware Overview

The System824 precision sound level meter with the 824-AUD firmware option is the heart of the Larson-Davis audiometer calibration system. This instrument and its firmware maintain and exceed the performance of previous Model 800B-based systems when used with the AUDit™ software. However, the System824 with 824-AUD firmware alone still possesses numerous analysis features useful for audiometer testing tasks such as:

- level
- frequency
- linearity
- total harmonic distortion
- pulse measurements
- crosstalk
- frequency modulation
- narrow band, broad band and speech noise

Some of these tests are slightly more tedious when performed manually. The following overview of the 824-AUD should be augmented by reading the user manual provided with your Model 824.

Selecting the 824-AUD Operation Mode

To enable the 824 audiometer testing firmware option, turn on the 824.

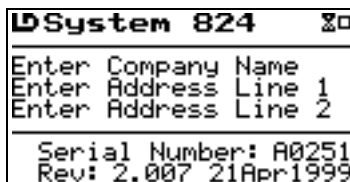


Figure 18-1 *System 824 Start Screen*

After the start screen is drawn, press $\odot$ SETUP and use the arrow keys ($\blacktriangleright$ $\blacktriangleleft$) to highlight the AUDTest.AUD setup. (figure 18-1) If this setup does not appear, your 824 may not have the 824-AUD firmware option.

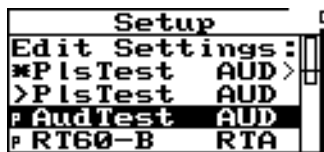


Figure 18-2 *AUD selection in setup menu of System 824*

Press the check key $\odot$ to retrieve the current setup and enter the audiometer calibration mode. The *SLM+RTA Live* screen will appear.

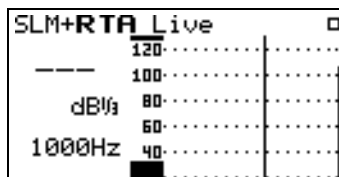


Figure 18-3 *AUD SLM + RTA Live Screen*

The screen shown in figure 18-2 shows the third octave spectrum. In this example, the measurement is reset and the cursor is placed on the 1000Hz third octave frequency. At this time, the instrument should be calibrated manually. Please refer to the 824 manual for information on calibrating the instrument.

SLM+RTA Mode

In the SLM+RTA mode, the 824 can be used for the following measurements:

- frequency
- linearity
- crosstalk

This mode consists of two screens: the SLM+RTA Live screen and the Any Level-a screen.

SLM+RTA Live screen

This is the default screen for the AUDTest.AUD setup. To access it from another screen, press the VIEW key , then select the SLM/RTA with the up/down arrows   and press the check key  (figure 18-3).



Figure 18-4 *SLM + RTA View Menu item*

To measure the level in dB re 20 micropascals, place the cursor on the frequency of interest and read the frequency and value on the left hand side of the screen (figure 18-4). Levels must be corrected by using coupler/earphone RETSPLs and microphone or other such corrections to arrive at the dB HL value.

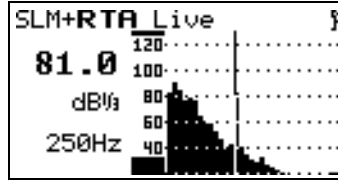


Figure 18-5 *SLM + RTA Live Screen*

Linearity evaluation can easily be performed by placing the cursor on the audiometric presentation frequency, then varying the hearing level output and monitoring the measured level on the 824.

Similarly, cross talk measurements are performed with the non-test earphone being measured, then comparing the test earphone level to that measurement.

Any Level-a Screen

This screen is accessed by pressing the VIEW key, then selecting the SLM/RTA with the up/down arrows and press the check key $\checkmark$. Once in the SLM+RTA Live screen, press the up or down arrow $\blacktriangle$ $\blacktriangledown$ to display the Any Level-a screen.

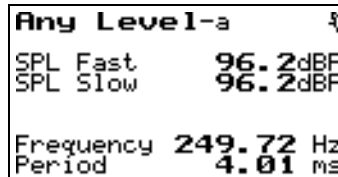


Figure 18-6 *Any Level - a Screen*

This screen displays the current overall Fast and Slow time averaged sound pressure level reading without frequency weighting (dB F for flat). This level will vary with the audiometer output, but also may vary due to signal components other than the audiometric frequency. Therefore, linearity measurements made with these levels will not be accurate at lower levels.

The frequency and period of the signal measured by the sound level meter are also displayed at the bottom of the screen. It may be necessary to increase the audiometer HL output level for a more stable measurement.

FFT Mode

In the FFT mode, the 824 can be used for the following measurements:

- harmonic distortion
- narrow and broad band noise

This mode consists of a single screen: the FFT screen.

FFT Screen

To access the FFT screen from another screen, press the VIEW key , then select FFT with the up/down arrows   and press the check key  (figure 18-5).

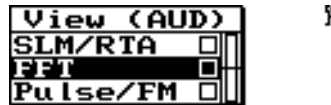


Figure 18-7 *FFT View Menu Item*

This will display the FFT screen (figure 18-6).

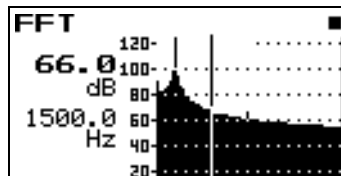


Figure 18-8 *FFT Screen*

The FFT measurement can be tailored with a number of variables. To enter the menu where these are selected, press the check key $\checkmark$.

You can now use the arrow and check keys to change the FFT gain (-20 to +50 in 10 dB steps), bandwidth (200, 500, 1K, 2K, 5K, 10K, and 20K hertz), and window (Hanning or rectangular).

To read a level in dB re 20 micropascals, place the cursor on the frequency of interest and read the frequency and value on the left hand side of the screen. In this mode, levels must also be corrected by using coupler/earphone RETSPLs and microphone or other such corrections to arrive at dB HL value.

An example of the application of FFT measurement to total harmonic distortion would be the selection of a 5000 kHz bandwidth to measure the distortion of the 500 Hz audiometer signal. In this way, the first four harmonics will be available.

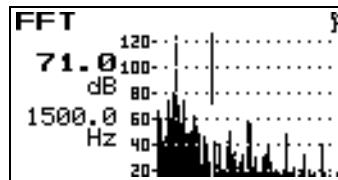


Figure 18-9 *FFT Screen, 1500 Hz.*

Figure 18-5 shows that the 1500 Hz third harmonic has a level of 71.0 dB, which is 52 db below the fundamental at 500 Hz. Since the ANSI S3.6-1996 prescription states that the third harmonic must be 2.0% or less than the fundamental at this frequency, this value is satisfactory (2/100 is -34 dB down).

Total harmonic distortion could be calculated from the distortion harmonics.

Noise measurements can also be performed in the FFT mode, especially the narrowband noise frequency cut-offs and the white noise flatness.

Pulse/FM Mode

In the Pulse/FM mode, the 824 can be used for the following measurements:

- pulse measurements
- frequency modulation measurements

This mode consists of two screens: the Pulse/FM-a and Pulse/FM-b screens.

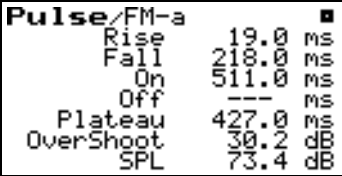
Pulse/FM-a Screen

To access the Pulse/FM-a screen from another screen, press the VIEW key , then select Pulse/FM with the up/down arrows and press the check key  (figure 18-8).



Figure 18-10 *Pulse/FM view menu item*

This will display the Pulse/FM-a screen (Figure 18-9).

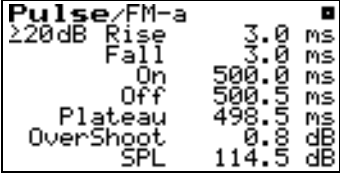


Pulse/FM-a			■
Rise	19.0	ms	
Fall	218.0	ms	
On	511.0	ms	
Off	---	ms	
Plateau	427.0	ms	
OverShoot	30.2	dB	
SPL	73.4	dB	

Figure 18-11 *Pulse/FM-a Screen*

This very simple shows all the required values for the calibration of the pulsed tone capabilities of an audiometer. Present the pulsed tone at a proper level and press the RUN/

STOP key . The stability of the measurement can be evaluated visually. To retrieve data, press RUN/STOP again  and read the values from the screen (figure 18-10).



Pulse/FM-a			
220dB	Rise	3.0	ms
	Fall	3.0	ms
	On	500.0	ms
	Off	500.5	ms
	Plateau	498.5	ms
	OverShoot	0.8	dB
	SPL	114.5	dB

Figure 18-12 *Pulse/FM Screen with Values*

The following values are displayed: rise time, fall time, on time, off time, plateau duration all in milliseconds, as well as overshoot in dB.

More information on the values and the process used by the 824 to measure these values may be found in the chapter on Pulse Measurements and in the appendices.

Pulse/FM-b Screen

To access the Pulse/FM-b screen from another screen, press the VIEW key , then select Pulse/FM with the up/down arrows and press the check key .



Figure 18-13 *Pulse/FM view menu item*

This will display the Pulse/FM-a screen. Press the left or right arrow   to view the Pulse/FM-b screen (figure 18-12).

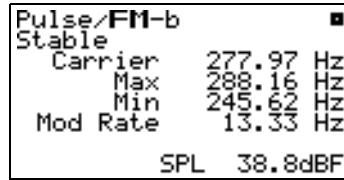


Figure 18-14 *Pulse/FM-b screen*

This screen displays required values for the calibration of the frequency modulated tone capabilities of an audiometer. Present the frequency modulated tone at an appropriate level and press the RUN/STOP key (⏮). The stability of the measurement can be evaluated visually. To retrieve data, press RUN/STOP (⏮) again and read the values from the screen (figure 18-13).

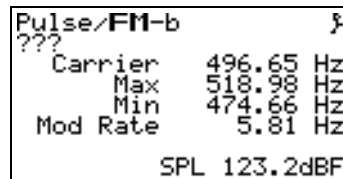


Figure 18-15 *Pulse/FM-b screen with values*

The following values are displayed: carrier frequency, maximum frequency, minimum frequency, modulation rate, all in hertz. More information on the values and the process used by the 824 to measure these values may be found in the chapter on Frequency Modulation Measurements and in the appendices.

A

AEC100 Artificial Ear

The Larson Davis AEC100 Artificial Ear is a precision acoustic coupler designed primarily for the calibration and test of supra-aural earphones used in audiometry. It is the coupler specified in *American National Standards Institute Specifications for Audiometers, S3.6-1996*. As a part of a system including a precision sound level meter, it allows accurate and repeatable measurements within its frequency response. It may also be used for production testing where correlation between the coupler and real ear response is not a requisite.

Standards Met

The AEC100 is designed to fulfill the requirements of the NBS Type 9-A earphone coupler described in section 5.2 of the American National Standards Institute *ANSI S3.7-1995 Methods for Coupler Calibration of Earphones* when used with the Larson Davis Model 2575 precision air condenser microphone, of equivalent volume 0.2 cc. It also conforms to the requirements of International Standard IEC 60318-3 (1998-08), Electroacoustics - Simulators of human head and ear - Part 3 Acoustic coupler for the calibration of supra-aural earphones used in audiometry.

Features

The AEC100 coupler and base are constructed of non-magnetic stainless steel. A teflon insulator with gold plated contacts and stainless spring-loaded pin links the microphone to

the preamplifier. The base has a non-skid rubber bottom and a vibration isolation pad is provided with the system.

In use, a protective cap is substituted for the microphone grid cap. It is also used to protect the spring loaded contact when the microphone is removed. The test earphone is securely contained by an earphone retainer ring made of durable black anodized aluminum. Clamping force is supplied by a nickel plated weight lowered in the retainer ring. This approach adapts to different earphones and avoids having to adjust complex spring loaded mechanisms.

Components

Please refer to figure A-1.

Index	Part Number	DESCRIPTION
1	MAE100.1	6 cc Coupler
2	MAE100.3	1 inch Coupler Cap
3	SP-MAE100.40	Artificial Ear Base Including Base, Contacts, Insulator And Pad
4	MAE100.6	Earphone Retainer Ring
5	MAEC100.7	Mass Handle
6	SAEC100.01	Weight Assembly
7	ACC001	Vibration Isolation Pad

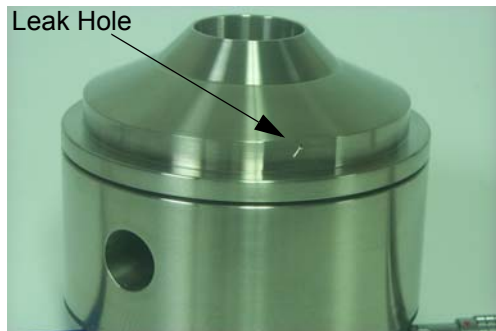
Figure 18-16 *Parts List for AEC100*

Initial Inspection and Assembly

The AEC100 artificial ear is an elegant, compact precision coupler built to provide a lifetime of dependable use with reasonable care. Read the following instructions to unpack, inspect and assemble the coupler for the first time.

Step 1 Remove the AEC100 components from their packaging. Note: You may wish to keep the packing materials to protect the coupler from dust and other contamination. Place the cushioned vibration isolation pad on a table or other such stable surface near the test system.

Step 2 Visually inspect the 6 cc coupler (MAE100.1) for gouges, scratches and dents which may affect the measurement, especially around the lip which will be in contact with the test earphone. Verify that the small metallic wire in the capillary leak hole is present with no other obstructions.



Step 3 Check the threaded hole on the weight assembly (SAEC100.01) for obstructions, and screw in the mass handle (MAEC100.7). The handle should screw in securely.



- Step 4** If installed, remove the coupler cap (MAE100.3) from the artificial ear base (SP-MAE100.40) by gently unscrewing it counterclockwise.



- Step 5** Inspect the spring-loaded contact at the center of the base visually. It should extend approximately 5 mm above the threaded ridge. The teflon insulator around it should be free of dust and other particles. Please do not handle the contact and protect it by keeping the coupler cap on whenever a microphone is not installed.

- Step 6** Working over the cushioned pad (ACC001), install the 1" microphone (LD Model 2575 or equivalent) on the center of the artificial ear base. The microphone should install easily: screw it finger tight.



- Step 7** Insert the 1/2" microphone preamplifier (LD Model PRM902 or equivalent) gently in the side port until its threads contact those of the base. The preamplifier should install easily: screw it finger

tight. Note: When removing the preamplifier, unscrew it by holding on its body, not the connector sleeve.



Step 8 Connect the instrument cable to the preamplifier. The coupler is now ready for level calibration.



Calibration

Level calibration is normally performed with a precision acoustic calibrator such as the Larson Davis Model CAL250. It offers an accuracy of ± 0.2 dB at 250Hz. When the measurement system contains a sound level meter, calibration is in dB SPL (with reference to 20 micropascals, 94 dB SPL = 1 pascal). If the measuring system requires a calibration in volts, the microphone sensitivity (usually expressed in mV/Pa) may be used to compute the voltage level produced by the calibrator. For example, a Model 2575 microphone with 47 mV/Pa sensitivity used with the 114 dB SPL (20 dB greater than 1 Pa or 10 Pa) signal of the CAL250 would result in a $10 \text{ Pa} \times 47 \text{ mV/Pa} = 470 \text{ mV}$ signal. These and most of the SPL values expressed in the 824 sound level meter are root mean square (rms) values. To calibrate the measurement system and artificial ear, follow the procedure below.

Step 1 Assemble the coupler as described in the Initial Inspection and Assembly section above. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.

Step 2 Place the calibrator opening on the microphone and seat it fully.



NOTE: Do not remove the microphone grid cap.

Step 3 Activate the calibrator and verify the stability of the indication on the measurement system. Do not hold the calibrator during calibration.



Step 4 Enter the calibration level (if required) on the measurement system and set the calibration. Please refer to the 824 manual if unfamiliar with this routine.

Step 5 The AUDit system requires a calibration in each of two measurement ranges. When this is required, the calibrator tone may have to be reactivated for the second calibration.

- Step 6** After the calibration, remove the microphone grid cap by holding the microphone body and unscrewing the grid counterclockwise. Carefully remove the grid cap and store it in the microphone case.



- Step 7** Replace the grid cap with the protective coupler cap (MAE100.3), being careful not to impact the delicate diaphragm.



Measurements

The Larson Davis AEC100 artificial ear coupler may be used for a number of precision electroacoustic test applications, such as audiometer calibration and earphone frequency response production testing.

Audiometer Calibration

The accuracy of a person's audiometric hearing evaluation is extremely important for clinical, legal, as well as personal reasons. The audiometers measuring hearing loss are complex instruments with signal generation, presentation and electroacoustic components which must be verified periodically to ensure accuracy and repeatability. Audiometers are

often located in test areas which must also be tested for ambient noise, and it is preferable not to remove them from their installation. Therefore, portable calibration systems are ideal.

The Larson Davis AEC100 artificial ear coupler is ideal for a lightweight portable calibration system. The LD SYS008 and SYS009 audiometer calibration systems include the coupler, as well as a precision sound level meter (System824) and software (AUDit) to perform exhaustive calibration according to the American National Standards Institute ANSI S3.7-1995 Methods for Coupler Calibration of Earphones and S3.6-1996 Specification for Audiometers. The following steps are suggested for audiometer calibration with the AEC100.

- Step 1** Assemble the coupler as described in the Initial Inspection and Assembly section above. The coupler base should rest on the isolation pad and ambient noise and vibration should be minimized.
- Step 2** Perform a calibration of the system as described in the Calibration section above and replace the microphone grid cap with the protective coupler cap (MAE100.3), being careful not to impact the delicate diaphragm.



- Step 3** Apply sealant (such as petroleum jelly) on the lower portion of the microphone to prevent air leakage from the coupler through paths other than

the capillary leak hole. Place the coupler over the base. The sealant should not affect the volume of the cavity or occlude the leak hole.



Step 4 Apply a thin (less than 1mm) film of sealant or rubber sheet on the contact area between coupler and earphone.

Step 5 Center the test earphone on the coupler. Lower the black retainer ring over the earphone, holding the earphone cable in line with the notch.



Step 6 Lower the appropriate mass on top of the earphone.



Step 7 The coupler and earphone are now ready for measurement. Set tone type, level and presentation and make the reading on the measurement system.

Earphone Frequency Response Production Testing

As is the case with other artificial ear couplers, the AEC100 approximates the average human ear only for a limited frequency range and with certain earphones. The responses may be significantly different from one earphone type to another. However, an exact correlation is not always required for production testing. It is possible to use the AEC100 as part of an accurate system for production testing of earphones or other electroacoustic transducers. Such a system may consist of the following components:

- Test earphone and adaptor to AEC100
- Larson Davis Model AEC100 coupler
- Larson Davis Model 2575 1" microphone
- Cable from earphone connector to BNC
- Larson Davis Model SRC20 synthesized signal source
- Precision amplifier (if required)
- Precision sound level meter such as Larson Davis Model 824-Lite or 824 with frequency analysis

Frequency response, level linearity and harmonic distortion can be measured using the signal generation capability of the SRC20, the coupler and precision sound level meter.

Specifications

Standards

Fulfills the requirements of:

- NBS Type 9-A earphone coupler described in section 5.2 of the *American National Standards Institute ANSI S3.7-1995 Methods for Coupler Calibration of Earphones*

- International Standard IEC 60318-3 (1998-08), *Electroacoustics - Simulators of human head and ear - Part 3 Acoustic coupler for the calibration of supra-aural earphones used in audiometry*

when used with the Larson Davis Model 2575 precision air condenser microphone.

Physical

Nominal effective acoustic volume: 5800 mm³

Microphone type: conforming to ANSI S1.12-1967 (R-1997) Type L1SP (1" nominal diameter) or IEC 61094-4 (1995-11) type WS1P without grid cap

Microphone mounting thread: 0.9098-60 UNS-2A

Preamplifier mounting thread: 0.4606-60 UNS-2B

Maximum diameter: 82 mm (3.2")

Height: 64 mm (2.5") without weight and earphone retainer ring, 110 mm (4.4") with earphone retainer ring

Weight: 2.5 kg (5.5 lb)

Calibration Environmental Conditions

Reference ambient pressure: 101.3 kPa

Reference temperature: 23° C

Reference relative humidity: 50%

IEC 318-3 Calibration should be performed at the above conditions within $\pm 3,0$ kPa, $\pm 3,0$ °C, and $\pm 20\%$ R.H. or else actual values should be stated.

Environmental

Operating temperature: 5 to +40° C

Operating relative humidity: 0 to 90%

Storage temperature: -25 to +70° C

Storage relative humidity: 0 to 90%

Compatibility

Microphone: Larson Davis Model 2575/Bruel & Kjaer Type 4144 1 inch condenser microphone or equivalent

Preamplifier: Larson Davis Model PRM902, 904, 900, 826B, Bruel & Kjaer microphone preamplifier Type 2669 or equivalent

Please contact Larson Davis for compatibility with other microphones or preamplifiers.

B

824 Technical Specifications

The specifications contained in this chapter are subject to change without notice. Please refer to calibration and test results for data on a specific unit.

These specifications are valid for all System 824's using the following options:

- PRM902 preamp
- 2541 (or 2560) free-field or random high sensitivity microphones
- 2540 (or 2559) free-field or random normal sensitivity microphones

NOTE: Where possible, tests were performed electrically using an AD005 microphone adapter (18 pF).

Standards Met:

- ANSI S1.4 - 1985 Type 1
- IEC 60651 - 1979 Type 1
- IEC 60804 - 1985 Type 1
- IEC 60651 - 1993 Type 1
- IEC 60804 - 1993 Type 1
- IEC 61260 - 1994 Class 1

NOTE: The 824 does not meet IEC 60604 or ANSI S1.4 specifications when used with a high sensitivity microphone (2541 or 2560) and a 20 volt bias. The bias is changed to 20 volts for high range measurements in the ISM and LOG modes, and -10dB or -20dB gain in all other modes.

System 824 Main Characteristics:

- Type 1 Precision Integrating Sound Level Meter with real-time 1/3 Octave Filters
- 2 MB standard memory
- Large backlit graphic display (64 X 128 pixels)
- Icon-driven graphic user interface
- Soft rubber backlit keys
- Large dynamic range
- RMS Detectors: Slow, Fast, Impulse
- Triple Peak Detectors: A, C, FLat
- Interval History (statistical)
- Time History
- L_n statistics (L0.01 through L99.9 available)
- Histogram tables
- Direct report printouts to laser printer
- Windows™-based software for setup, control, and high speed data download and reporting
- Advanced Windows™-based software packages (optional) provides data archiving/search capabilities, post-measurement analysis features, and advanced sorting and graphics/report generation tools.
- Multi-tasking processor allows measuring while viewing data, transferring data, or printing
- Programmable Run/Stop timer for automatic measurements
- AC/DC outputs to recorder
- Field-upgradable firmware: keeps instrument current with the latest features via ROM disk upgrades
- Two-year limited warranty

General Specifications

Reference level:	114.0 dB SPL
Reference frequency:	1000 Hz
Reference direction:	0° for a free field microphone and 80° for a random incidence microphone
Temperature:	≤ ± 0.5 dB error between -10° C and 50°C
Storage temperature:	-10°C to 60°C

Humidity:	$\leq \pm 0.5$ dB error between 30 and 90% relative humidity at 40°C
Equivalent mic impedance:	18 pF for Larson-Davis ½" microphone
Range level error:	$< \pm 0.1$ dB relative to the reference range
Calibration procedure: Using a Larson-Davis CAL200 or equivalent calibrator, insert the microphone fully into the calibrator. Set the calibrator to 114 dB SPL. On the 824 press the tools  key, arrow down to "Calibration" and press the right arrow  key. From the calibration menu use the down arrow  key and highlight "Change". Press the check  key to initiate the calibration. The 824 will prompt you to turn the calibrator on with "Calibrator Active?". Select "Yes" after turning the calibrator on and press the check  key. The 824 performs the calibration change.	
Effect of Magnetic Field:	80 A/m (1 Gauss) @ 60 Hz produces a change of < 16.5 dB SPL - passes Class 1 according to IEC 61672
Vibration Sensitivity:	73.7 dB with linear- weighting at 1.0 m/ sec ² referenced to 58.1 dB
Warm-up Time:	45 sec
Effect of an extension cable on calibration:	none

AC/DC Output

AC output voltage range:	± 3 Volts peak
DC output voltage range:	0 to 3 Volts peak, 28 mV per dB, with a dynamic range of 120 dB, resolution 0.1 dB. (0 dB is defined as the "Start Level Setting")
AC/DC output impedance:	~600 Ohms, error: < 0.1 dB for input impedances > 52 K Ohms
AC/DC output connector:	3.5mm stereo jack

Power Supply

Batteries:	3 AA alkaline cells or NiMH battery pack
Internal charge time:	< 6 hours
Operating time	~4 hours
AC power input	6-15 Volts at 1 amp, max.
Typical AC power	150 mA @ 12 Volts
AC power connector	5.5mm x 2.5mm coaxial power plug

Physical Characteristics

Length:	9.9 inches	25.1 cm
Width:	3.4 inches	8.6 cm
Depth:	1.6 inches	4.0 cm
Weight:	18 oz	0.51 kg

Resolution

Levels:	0.1dB (0.01 dB via I/O)
Dose:	0.01%
Elapsed time:	0.005 seconds
Real time clock	1 second
Calendar:	01 Jan 1996 - 31 Dec 2095

Cable Drive Capability (with PRM902 preamp)

Frequencies to 20 kHz:	700 feet	213 meters
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Cable Drive Capability (with PRM902 preamp)

Frequencies to 10 kHz:	1000 feet	305 meters
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Maximum RMS Voltage Input

Gain	VRMS	Vp-p	dBuV
0 dB	4.24	6.00	135.6
10 dB	1.34	1.9	125.6
20 dB	0.42	0.60	115.6
30 dB	0.13	0.19	105.6
40 dB	0.042	0.06	95.6
50 dB	0.013	0.02	85.6

Frequency Weightings

Nominal Freq.	Exact Freq.	Flat	A Weight	C Weight	Electrical Tolerance	Mic. Tolerance
10	10.00	-6.0	-70.4	-14.3	±1.8	±2.2
12.5	12.59	-4.2	-63.4	-11.2	±1.5	±2.0
16	15.85	-2.9	-56.7	-8.5	±1.2	±1.8
20	19.95	-1.9	-50.5	-6.2	±1.0	±1.5
25	25.12	-1.3	-44.7	-4.4	±0.9	±1.1
31.5	31.62	-0.8	-39.4	-3.0	±0.7	±0.8
40	39.81	-0.5	-34.6	-2.0	±0.7	±0.8
50	50.12	-0.3	-30.2	-1.3	±0.5	±0.5
63	63.10	-0.2	-26.2	-0.8	±0.5	±0.5
80	79.43	-0.1	-22.5	-0.5	±0.5	±0.5
100	100.00	-0.1	-19.1	-0.3	±0.5	±0.5
125	125.00	0.0	-16.1	-0.2	±0.5	±0.5
160	158.50	0.0	-13.4	-0.1	±0.5	±0.5
200	199.50	0.0	-10.9	0.0	±0.5	±0.5

Frequency Weightings

250	251.20	0.0	-8.6	0.0	±0.5	±0.5
315	316.20	0.0	-6.6	0.0	±0.4	±0.6
400	398.10	0.0	-4.8	0.0	±0.4	±0.6
500	501.20	0.0	-3.2	0.0	±0.4	±0.6
630	631.00	0.0	-1.9	0.0	±0.4	±0.6
800	794.30	0.0	-0.8	0.0	±0.4	±0.6
1000	1000.00	0.0	0.0	0.0	±0.4	±0.6
1250	1259.00	0.0	0.6	0.0	±0.4	±0.6
1600	1585.00	0.0	1.0	-0.1	±0.4	±0.6
2000	1995.00	0.0	1.2	-0.2	±0.4	±0.6
2500	2512.00	0.0	1.3	-0.3	±0.4	±0.6
3150	3162.00	0.0	1.2	-0.5	±0.4	±0.6
4000	3981.00	0.0	1.0	-0.8	±0.4	±0.6
5000	5012.00	0.0	0.5	-1.3	±0.5	±1.0
6300	6310.00	0.0	-0.1	-2.0	0.5, -0.7	1.0, -1.4
8000	7943.00	0.0	-1.1	-3.0	0.5, -1.0	1.0, -2.0
10000	10000.00	0.0	-2.5	-4.4	0.7, -1.3	1.3, -2.7
12500	12590.00	0.0	-4.3	-6.2	1.0, -2.0	2.0, -4.0
16000	15850.00	0.0	-6.6	-8.5	1.0, -3.0	2.0, ∞
20000	19950.00	0.0	-9.3	-11.2	1.0, -4.0	2.0, ∞

SSA Mode Specifications (IEC 61260 Class 1)

Overall time weighting:	Slow, Fast, Impulse, TWA and Peak
1/3 octave filter time weighting:	Slow, Fast
Dynamic range:	> 93 dBA (overload to noise floor)
Linearity range:	> 80 dBA
Pulse range:	> 83 dBA
RMS noise floor:	< 33 dBA typical with PRM902, 2541 microphone, and 0 dB gain
Reference level range:	0 dB gain
Exchange rates:	3, 4, 5, or 6 dB
Sample rate:	51,200 Hz
1/3 octave band frequencies:	12.5 Hz - 20 kHz
Filter integrated response:	≤ ±0.15dB for all filters.

Real-time operation:	$\leq \pm 0.3$ dB error for all filters tested with a swept sinusoidal input.
Anti-aliasing:	≥ 75 dB
Summation of output signals:	$\leq \pm 1.0$ dB (± 0.4 dB typical)
Flat frequency range:	10 Hz - 20 kHz, relative attenuation $< \pm 0.15$ dB
Filter type:	Digital
Octave frequency ratio:	Base 2 (See IEC 1260 Annex A)

AC/DC Output (SSA mode only)

824 Menu	3.5mm Connector Tip	3.5 mm Connector Ring
AC-1 AC-2	Flat AC output	C-weighted AC output
AC-1 DC	Flat AC output	Weighted DC output
AC-2 DC	C-weighted AC output	Weighted DC output
AC-2 AC-1	C-weighted AC output	Flat AC output

NOTE: AC output gain matches RMS detector.

Measurement Range (SSA mode only) Typical

	0dB Gain				10dB Gain				20db Gain				30dB Gain				40dB Gain				50dB Gain			
	NF	Start	End	Range	NF	Start	End	Range	NF	Start	End	Range	NF	Start	End	Range	NF	Start	End	Range	NF	Start	End	Range
A	33	48	128	80	24	38	118	80	15	28	108	80	8	23	98	75	7	20	88	68	6	20	78	58
C	32	48	128	80	23	38	118	80	16	28	108	80	9	23	98	75	8	20	88	68	8	20	78	58
FLA	32	48	128	80	25	38	118	80	21	33	108	75	21	33	98	65	26	33	88	50	23	40	78	38
16.0	2	45	128	83	2	35	118	83	1	25	108	83	2	25	98	73	-1	28	88	60	1	23	78	55
31.5	3	43	128	85	1	35	118	83	1	23	108	85	2	25	98	73	-4	22	88	66	-4	23	78	55
63.0	4	40	128	88	0	33	118	85	1	23	108	85	0	22	98	76	-7	15	88	73	-7	18	78	60
125	2	40	128	88	-2	27	118	91	-3	28	108	80	-2	18	98	80	-9	11	88	77	-8	8	78	70
250	3	37	128	91	-3	25	118	93	-3	15	108	93	-4	15	98	83	-10	8	88	80	-9	8	78	70
500	12	33	128	95	4	25	118	93	-3	15	108	93	-4	13	98	85	-10	6	88	82	-10	8	78	70
1000	10	32	128	96	2	20	118	98	-4	15	108	93	-5	13	98	85	-10	6	88	82	-10	8	78	70
2000	15	32	128	96	6	20	118	98	-2	15	108	93	-5	13	98	85	-8	8	88	80	-8	8	78	70
4000	14	32	128	96	7	20	118	98	0	15	108	93	-2	13	98	85	-6	8	88	78	-6	8	78	70
8000	14	32	128	96	7	20	118	98	1	15	108	93	-1	13	98	85	-2	12	88	76	-3	13	78	65

NOTE: A-weighting, C-weighting, and Flat are measured to ANSI S1.4 and IEC 60651 standards for SLM linearity. 1/3 octave filters listed are measured to the IEC 61260 standard for Class 0 linearity which is ± 0.3 dB. The numbers in the table represent SPL levels with a typical 2541 microphone which has 44.1 mV/Pa sensitivity.

*NF is noise floor.

AUD Mode Specifications

AC/DC output:	For AUD, AC and DC outputs are undefined.
Pulse mode:	The pulse test output is computed from a Discrete Hilbert Transform which is sampled every $\frac{1}{2}$ millisecond. The Discrete Hilbert Transform produces a mathematically correct sample of the input waveform envelope.
Time resolution:	0.5 ms to 1.0 seconds in 0.5 ms increments
Time accuracy:	± 1.0 ms
Hilbert transform magnitude error:	< 0.1 dB
Dynamic range:	> 80 dB
Hilbert transform Sample rate:	2000 Hz
On level computation:	After the "ON" state has been detected, the "ON" level is computed as the average of 32 samples.
Overshoot computation:	Overshoot is calculated as the maximum sample level minus the averaged "ON" level
Measurement conditions:	Conditions that must be met to produce output: • ON/OFF modulation must be greater than 20 dB (90%). • The "ON" state must be stable within ± 0.5 dB for at least 20 ms. • Pulse transition from high to low must occur within 2 seconds of the transition from low to high for the fall time to be calculated. If this time is greater than 2 seconds, the 824 will revert to looking for the pulse rise time.

FM Modulation Tests

The FM modulation test code computes the minimum and maximum periods of the input waveform. The minimum and maximum frequencies are the inverse of the average of the last 8 periods. The carrier frequency is an exponential average of all waveform periods. Signal will be flagged as stable if the carrier period varies less than 8 microseconds for 1 second.

Carrier frequency (F_c):	$20 \text{ Hz} \leq f_c \leq 16000 \text{ Hz}$
Modulating frequency (f_m):	$3 \text{ Hz} \leq f_m \leq 100 \text{ Hz}$
Carrier to modulating frequency ratio:	$f_c > f_m * 5$
Signal amplitude:	Overload -35dB to Overload

SLM/RTA

The 1/3 octave filters used in the audiometric calibration firmware are the same filters as are used in the SSA firmware and meet the same specifications, (page D-8).

400 Line FFT

Averaging:	Count
Window:	Rectangular or Hanning
Linearity range:	>85 dB with Hanning window, 20 kHz bandwidth, and PRM902
Dynamic range:	>100 dB
Flat SPL linearity range:	>75 dB

Pressure Response of Free-Field Microphones (Variation over Pressure)

Pressure	650 mB	750 mB	850 mB	925 mB	1013 mB	1100 mB
2520	.3831 dB	.2049 dB	.1371 dB	.0688 dB	0.000	-.0462 dB
2540	.3396 dB	.2391 dB	.1488 dB	.0804 dB	0.000	-.0753 dB
2541	.4272 dB	.3062 dB	.1891 dB	.0989 dB	0.000	-.1019 dB

NOTE: Results in dB referenced to 1013
mB

Position of Instrument and Operator:

When making a measurement, it is recommended that the observer be positioned as far behind and to the right of the instrument as possible to minimize interference of the sound field at the microphone resulting from body reflections. When using the 824, the meter is held in one hand with the arm extended away from the body. Better results can be obtained by using a tripod.

Free-Field to Random Corrections

Freq	Diffuse	F.F.	Corr.	Freq	Diffuse	F.F.	Corr.
251	0.14	0.15	0.01	2326	-0.11	0.50	0.61
271	0.06	0.16	0.10	2512	-0.05	0.52	0.57
293	0.10	0.16	0.06	2712	-0.16	0.45	0.61
316	0.09	0.12	0.03	2929	-0.28	0.44	0.72
341	0.05	0.12	0.07	3162	-0.34	0.24	0.58
369	0.05	0.17	0.12	3415	-0.37	0.15	0.52
398	0.07	0.15	0.08	3687	-0.42	0.32	0.74
430	0.06	0.11	0.05	3981	-0.51	0.47	0.98

464	0.06	0.06	0.00	4299	-0.63	0.32	0.95
501	0.07	0.05	-0.02	4642	-0.95	0.11	1.06
541	0.09	0.04	-0.05	5012	-0.99	0.49	1.48
584	0.09	0.06	-0.03	5412	-1.15	0.28	1.43
631	0.06	0.06	0.00	5843	-1.21	0.48	1.69
681	0.14	0.11	-0.03	6310	-1.57	0.44	2.01
736	0.01	-0.03	-0.04	6813	-1.77	0.21	1.98
794	0.02	-0.05	-0.07	7356	-1.98	0.42	2.40
858	0.07	0.02	-0.05	7943	-2.29	0.70	2.99
926	-0.01	-0.06	-0.05	8577	-2.40	0.48	2.88
1000	0.03	0.00	-0.03	9261	-2.76	0.61	3.37
1080	0.03	0.13	0.10	10000	-2.76	0.32	3.08
1166	-0.02	0.24	0.26	10798	-3.05	0.44	3.49
1259	-0.05	0.24	0.29	11659	-3.56	0.62	4.18
1359	-0.04	0.28	0.32	12589	-3.91	0.36	4.27
1468	0.03	0.36	0.33	13594	-4.53	0.02	4.55
1585	0.00	0.44	0.44	14678	-4.94	0.27	5.21
1711	0.02	0.09	0.07	15849	-5.27	0.55	5.82
1848	-0.03	0.00	0.03	17113	-5.73	0.46	6.19
1995	-0.07	-0.21	-0.14	18479	-5.99	0.68	6.67
2154	-0.13	0.18	0.31	19953	-6.31	0.57	6.88

C

*Sample Reports***Examples of Reports from AUDit™**

This appendix contains examples of the reports that can be created using the AUDit™ software.

Audiometer Calibration Meas. Experts

1234 ACME Boulevard

Anytown, PE 45678 (999)555-1212

Calibration Date: 1999-04-20

Technician: asdfasd

Customer: John Wilkes

New Clinic

1 Clinic Circle, Anytown, PE 09876

Audiometer

Manufacturer: Grason Stadler

Model Number: 1716

Serial Number: 5804

Number of Channels: 2

Type: 1

Inventory #: LD001161

Channel Tested: 1

Earphones

Supra-aural

Insert

Circumaural

Manufacturer: Telephonics

Etymotic

Sennheiser

Model Number: TDH 50

ER-3A

HDA200

Right S/N: C 13364

Left S/N: C 13363

Bone Vibrator

Manufacturer: Radioear

Model Number: B-71

Serial Number: 8000-0130

Speakers

Left

Right

Manufacturer: DBOX

DBOX

Model Number: DB25

DB25

Serial Number: 0255

0253

Instrumentation	Manufacturer	Model	Serial Number	Cal Due
Sound Level Meter	Larson-Davis	824	0251	1999-12-05
Preamp	Larson-Davis	PRM902	0252	1999-12-05
Calibrator	Larson-Davis	CAL250	2702	2001-02-18
Mastoid	Larson-Davis	AMC493	1047	1999-03-20
Open Air Mic	Larson-Davis	2575	1338	2001-03-28
IEC 318 Mic	Larson-Davis	2575	1338	2001-03-28
NBS 9A Mic	Larson-Davis	2575	1338	2001-03-28
IEC 711 Mic	Larson-Davis	2575	1338	2001-03-28
HA-1 Mic	Larson-Davis	2575	1338	2001-03-28

Test Name	Supra-aural Earphones	Bone Vibrator	Speakers	Insert Earphones	Circumaural Earphones
Hearing Level	Pass	-	-	-	-
Frequency	FAIL	n/a	n/a	-	-
Linearity	FAIL	n/a	n/a	-	-
Harmonic Distortion	Pass	-	n/a	-	-
Pulse	Pass	n/a	n/a	-	-
Cross Talk	FAIL	n/a	n/a	-	-
Frequency Modulation	FAIL	n/a	n/a	-	-
Narrow Band Level	Pass	n/a	-	-	-
Broad Band Noise	-	n/a	n/a	-	-
Speech	-	-	-	-	n/a

----- Hearing Level Test Channel #: 1 -----
Supra-aural earphones

Left Earphone	Measured	Hearing	SPL	Target
Freq	SPL	Level	Deviation	SPL
(Hz)				
125	116.6	69.1	-0.9	114.5 to 120.5
250	95.3	68.8	-1.2	93.5 to 99.5
500	83.1	69.6	-0.4	80.5 to 86.5
750	76.9	68.4	-1.6	75.5 to 81.5
1000	77.1	69.6	-0.4	74.5 to 80.5
1500	76.8	69.3	-0.7	74.5 to 80.5
2000	81.3	70.3	0.3	78.0 to 84.0
3000	79.0	69.5	-0.5	76.5 to 82.5
4000	79.0	68.5	-1.5	77.5 to 83.5
6000	80.4	66.9	-3.1	78.5 to 88.5
8000	82.8	69.8	-0.2	78.0 to 88.0
12000	72.2	72.2	2.2	65.0 to 75.0

Right Earphone	Measured	Hearing	SPL	Target
Freq	SPL	Level	Deviation	SPL
(Hz)				
125	116.4	68.9	-1.1	114.5 to 120.5
250	95.4	68.9	-1.1	93.5 to 99.5
500	83.1	69.6	-0.4	80.5 to 86.5
750	77.0	68.5	-1.5	75.5 to 81.5
1000	77.1	69.6	-0.4	74.5 to 80.5
1500	76.6	69.1	-0.9	74.5 to 80.5
2000	81.3	70.3	0.3	78.0 to 84.0
3000	79.1	69.6	-0.4	76.5 to 82.5
4000	78.8	68.3	-1.7	77.5 to 83.5
6000	80.4	66.9	-3.1	78.5 to 88.5
8000	82.8	69.8	-0.2	78.0 to 88.0
12000	73.2	73.2	3.2	65.0 to 75.0

----- Frequency Accuracy Test Channel #: 1 -----				Supra-aural earphones	
		Left		Right	
Freq	Measured	Frequency	Target	Measured	Frequency
Hz	Frequency	Deviation	Frequency	Frequency	Deviation
125	124.7	-0.3	123.8 to 126.3	124.7	-0.3
250	249.6	-0.4	247.5 to 252.5	249.6	-0.4
500	498.1	-1.9	495.0 to 505.0	498.1	-1.9
750	746.3	-3.8	742.5 to 757.5	746.3	-3.7
1000	989.0	-11.0	990.0 to 1010.0	989.1	-10.9
1500	1485.4	-14.6	1485.0 to 1515.0	1485.5	-14.5
2000	1973.3	-26.7	1980.0 to 2020.0	1973.4	-26.6
3000	2960.6	-39.4	2970.0 to 3030.0	2960.7	-39.3
4000	3945.4	-54.6	3960.0 to 4040.0	3945.5	-54.5
6000	5920.0	-80.0	5940.0 to 6060.0	5920.1	-79.9
8000	7852.6	-147.4	7920.0 to 8080.0	7852.9	-147.1
12000	11833.7	-166.3	11880.0 to 12120.0	11833.5	-166.5

----- Linearity Test Channel #: 1 -----				Supra-aural earphones	
Left Earphone		Test frequency: 1000.0 Hz		Test step: 5 dB	
Dial	Measured	Measured	Step	Target	
Level	SPL	Step	Deviation	Step	
120	127.3				
115	123.0	4.3	-0.7	4.0 to 6.0	

110	118.0	5.0	-0.0	4.0 to 6.0
105	113.2	4.8	-0.2	4.0 to 6.0
100	107.9	5.3	0.3	4.0 to 6.0
95	103.2	4.7	-0.3	4.0 to 6.0
90	97.6	5.6	0.6	4.0 to 6.0
85	92.7	4.9	-0.1	4.0 to 6.0
80	87.6	5.1	0.1	4.0 to 6.0
75	83.1	4.5	-0.5	4.0 to 6.0
70	78.2	4.9	-0.1	4.0 to 6.0
65	73.2	5.0	-0.0	4.0 to 6.0
60	68.2	5.0	-0.0	4.0 to 6.0
55	63.9	4.3	-0.7	4.0 to 6.0
50	58.9	5.0	0.0	4.0 to 6.0
45	53.7	5.2	0.2	4.0 to 6.0
40	48.4	5.2	0.2	4.0 to 6.0
35	42.8	5.7	0.7	4.0 to 6.0
30	1.5	-1.5	-1.5	4.0 to 6.0
25	1.5			
20	1.5			
15	1.5			
10	1.5			
5	1.5			
0	1.5			

NF = 16.8 dB

Right Earphone		Test frequency: 1000.0 Hz			Test step: 5 dB
Dial Level	Measured SPL	Measured Step	Step Deviation	Target Step	
120	127.5				
115	123.0	4.5	-0.5	4.0 to 6.0	
110	118.2	4.8	-0.2	4.0 to 6.0	
105	113.0	5.1	0.1	4.0 to 6.0	
100	107.9	5.1	0.1	4.0 to 6.0	
95	103.1	4.8	-0.2	4.0 to 6.0	
90	97.9	5.2	0.2	4.0 to 6.0	
85	92.7	5.2	0.2	4.0 to 6.0	
80	87.7	5.0	-0.0	4.0 to 6.0	
75	83.1	4.6	-0.4	4.0 to 6.0	
70	78.0	5.1	0.1	4.0 to 6.0	
65	73.2	4.9	-0.1	4.0 to 6.0	
60	68.3	4.9	-0.1	4.0 to 6.0	
55	63.6	4.6	-0.4	4.0 to 6.0	
50	58.6	5.0	0.0	4.0 to 6.0	
45	53.7	5.0	-0.0	4.0 to 6.0	
40	48.7	5.0	-0.0	4.0 to 6.0	

NF = 40.8 dB

-----		Distortion Test			Channel #: 1 -----	
					Supra-aural earphones	
Left Earphone Frequency (Hz)	Fundamental (dB)	2nd Harm (dB)	3rd Harm (dB)	THD (%)	Deviation (%)	
125	121.7	56.5	71.8	0.3	-2.2	
250	115.8	46.3	65.7	0.3	-2.2	
500	122.0	50.0	60.4	0.1	-2.4	
750	117.9	52.7	68.1	0.3	-2.2	
1000	117.2	52.4	64.4	0.2	-2.3	
1500	117.0	55.9	59.5	0.2	-2.3	
2000	119.8	59.1	46.2	0.1	-2.4	

3000	140.0	63.9	65.4	0.0	-2.5
4000	138.6	59.3	78.9	0.1	-2.4
6000	109.3	52.0		0.2	-2.3
8000	106.2	40.9		0.1	-2.4

Right Earphone					
Frequency (Hz)	Fundamental (dB)	2nd Harm (dB)	3rd Harm (dB)	THD (%)	Deviation (%)
125	146.0	85.4	95.6	0.3	-2.2
250	139.9	79.2	89.5	0.3	-2.2
500	145.9	81.9	84.9	0.1	-2.4
750	141.7	81.4	91.8	0.3	-2.2
1000	140.9	80.0	88.8	0.3	-2.2
1500	141.6	79.5	87.2	0.2	-2.3
2000	143.5	77.3	74.1	0.1	-2.4
3000	140.0	63.6	65.3	0.0	-2.5
4000	138.6	58.6	79.1	0.1	-2.4
6000	108.2	52.5		0.2	-2.3
8000	106.3	41.2		0.1	-2.4

Pulse Test					
Channel #: 1 -----					
Supra-aural earphones					
Freq (Hz)	Rise Time (ms)	Fall Time (ms)	On Time (ms)	Off Time (ms)	Width (ms)
1000	35.5	35.5	195.5	209.0	166.5
					Ratio OK

Cross Talk Test					
Channel #: 1 -----					
Supra-aural earphones					
Test frequency: 1000 Hz	Tone On	Tone Off	Difference	ANSI Limits	Deviation
Test	87.2	1.5	-1.5	>= 70.0	-1.5
Left to Right	87.2	1.5	-1.5	>= 70.0	-1.5
Right to Left	87.2	1.5	-1.5	<= 17.5	8.7
On/Off Ratio		8.8			

Frequency Modulation Test					
Channel #: 1 -----					
Supra-aural earphones					
Left Earphone	Carrier	Minimum	Maximum	Repetition	Frequency
Dial	Frequency	Frequency	Frequency	Rate	Deviation
125	124.5	119.1	130.1	5.93	8.9%
250	248.9	238.2	260.5	5.93	9.0%
500	498.0	474.8	518.9	5.91	8.9%
750	744.3	710.1	781.0	5.93	9.5%
1000	986.7	940.9	1029.2	5.93	8.9%
1500	1776.1	1702.5	1858.3	7.12	8.8%
2000	2366.1	2258.9	2467.7	7.12	8.8%
3000	3539.8	3383.7	3698.6	7.10	8.9%
4000	4726.0	4513.8	4941.2	7.12	9.0%
6000	7089.2	6769.5	7406.1	7.11	9.0%
8000	9406.1	8991.2	9829.7	7.12	8.9%

Narrow Band Level Test					
Channel #: 1 -----					
Supra-aural earphones					
Left Earphone	Measured	Hearing	SPL	Target	
Freq (Hz)	SPL	Level	Deviation	SPL	
125	120.8	69.3	-0.7	118.5 to 126.5	
250	120.1	89.6	-0.4	117.5 to 125.5	
500	106.8	89.3	-0.7	104.5 to 112.5	

750	102.2	88.7	-1.3	100.5 to 108.5
1000	103.0	89.5	-0.5	100.5 to 108.5
1500	102.3	88.8	-1.2	100.5 to 108.5
2000	106.1	89.1	-0.9	104.0 to 112.0
3000	103.0	87.5	-2.5	102.5 to 110.5
4000	103.8	88.3	-1.7	102.5 to 110.5
6000	106.5	88.0	-2.0	105.5 to 113.5
8000	106.6	88.6	-1.4	105.0 to 113.0

Notes & Comments

P- pass F-fail

Left Earphone	P	Power Switch	P
Right Earphone	P	Fuse	P
Left Earphone Cushion	P	Tone interrupter	P
Right Earphone Cushion	P	Tone reverse switch	P
Left Earphone cord	P	Frequency selector switch	P
Right Earphone cord	P	Earphone selector switch	P
Headband	P	Response cord	P
Bone Conductor	P	Output selector switch	P
Bone Conductor cord	P	Chan 1 input selector switch	P
Power cord	P	Chan 2 input selector switch	P
Tone 'on' lamp	P	Function selector switch	P
Power 'on' lamp	P	Microphone	P
Attenuator	P	Monitor phone/speaker	P
Masking control	P	Manual/pulse tone control	P
Volume control	P	VU meter	P

Certificate of Calibration

Audiometer Calibration Meas. Experts
1234 ACME Boulevard
Anytown, PE 45678 (999)555-1212

Calibration Date: 1999-04-20
Technician: asdfasd
Customer: John Wilkes
New Clinic
1 Clinic Circle, Anytown, PE 09876

Audiometer
Manufacturer: Grason Stadler
Model Number: 1716
Serial Number: 5804
Number of Channels: 2
Type: 1
Inventory #: LD001161
Channel tested: 1

Earphones
Manufacturer: Supra-aural
Telephonics
Model Number: TDH 50
Right S/N: C 13364
Left S/N: C 13363
Insert
Etymotic
ER-3A
Circumaural
Sennheiser
HDA200

Bone Vibrator
Manufacturer: Radioear
Model Number: B-71
Serial Number: 8000-0130

Speakers
Left
Manufacturer: DBOX
Model Number: DB25
Serial Number: 0255
Right
DBOX
DB25
0253

Instrumentation	Manufacturer	Model	Serial Number	Cal Due
Sound Level Meter	Larson-Davis	824	0251	1999-12-05
Preamp	Larson-Davis	PRM902	0252	1999-12-05
Open Air Mic	Larson-Davis	2575	1338	2001-03-28
IEC 318 Mic	Larson-Davis	2575	1338	2001-03-28
NBS 9A Mic	Larson-Davis	2575	1338	2001-03-28
IEC 711 Mic	Larson-Davis	2575	1338	2001-03-28
HA-1 Mic	Larson-Davis	2575	1338	2001-03-28
Calibrator	Larson-Davis	CAL250	2702	2001-02-18
Mastoid	Larson-Davis	AMC493	1047	1999-03-20

Audiometer Calibration Meas. Experts certifies that this audiometer meets or exceeds the minimum specifications described in the American National Standards Institute Specification for Audiometers. (ANSI S3.6 1996)

Signature: _____

asdfasd

Date Issued: 1999-06-10

Certificate of Calibration (Audiometer)

Certificate of Compliance

Audiometer Calibration Meas. Experts
1234 ACME Boulevard
Anytown, PE 45678 (999)555-1212

Measurement Date: 1999-06-10

Customer: Basil Corti
NADA Field Testing Facility

Booth: Kwayet Technologies Booth 1

Instrumentation	Manufacturer	Model	Serial Number	Cal Due
Sound Level Meter	Larson-Davis	824	0251	1999-12-05
Preamplifier	Larson-Davis	PRM902	0252	1999-12-05
Microphone	Larson-Davis	2575	1338	2001-03-28
Calibrator	Larson-Davis	CAL250	2702	2001-02-18

Audiometer Calibration Meas. Experts certifies that this booth meets
or exceeds the minimum specifications described in the American
National Standards Institute Specification for Audiometric Test Rooms.
(ANSI S3.1 1991)

Signature: _____

Date Issued: 1999-06-10

Certificate of Compliance (Booth)

Audiometer Calibration Meas. Experts

1234 ACME Boulevard
Anytown, PE 45678 (999)555-1212

Measurement Date: 1999-06-10

Booth: Kwayet Technologies Booth 1

Customer: Basil Corti
NADA Field Testing Facility

Instrumentation	Manufacturer	Model	Serial Number	Cal Due
Sound Level Meter	Larson-Davis	824	0251	1999-12-05
Preamplifier	Larson-Davis	PRM902	0252	1999-12-05
Mic	Larson-Davis	2575	1338	2001-03-28
Calibrator	Larson-Davis	CAL250	2702	2001-02-18

Frequency (Hz)	Measured SPL	125 to 8000 Hz		250 to 8000 Hz		500 to 8000 Hz	
		ANSI Max Covered	ANSI Max Uncovered	ANSI Max Covered	ANSI Max Uncovered	ANSI Max Covered	ANSI Max Uncovered
31.5	47.4	57.0	51.0	59.5	55.5	70.5	65.5
63	42.6	43.0	37.0	45.5	41.5	56.5	51.5
125	25.8	29.0	23.0	31.5	27.5	42.5	37.5
250	16.0	17.5	13.5	17.5	13.5	28.5	23.5
500	10.0	14.5	9.5	14.5	9.5	14.5	9.5
800	6.8	16.5	7.5	16.5	7.5	16.5	7.5
1000	3.4	21.5	9.0	21.5	9.0	21.5	9.0
1600	0.1	21.5	5.5	21.5	5.5	21.5	5.5
2000	2.4	23.0	3.5	23.0	3.5	23.0	3.5
3150	0.4	28.5	3.5	28.5	3.5	28.5	3.5
4000	0.9	29.5	4.0	29.5	4.0	29.5	4.0
6300	2.6	33.0	9.0	33.0	9.0	33.0	9.0
8000	2.9	38.5	15.5	38.5	15.5	38.5	15.5

Booth Report

D

Glossary

This appendix contains technical definitions of key acoustical and vibration terms commonly used with Larson•Davis instruments. The reader is referred to American National Standards Institute document S1.1-1994 for additional definitions. Specific use of the terms defined are in the main body of the text.

Average Sound Level (L_{avg})

It is the logarithmic average of the sound during a Measurement Duration (specific time period), using the chosen Exchange Rate Factor. Exposure to this sound level over the period would result in the same noise dose and the actual (unsteady) sound levels. If the Measurement Duration is the same as the Criterion Duration, then $L_{avg} = L_{TWA}(LC)$

$$L_{avg} = q \log_{10} \left(\frac{1}{T} \int_{T_1}^{T_2} 10^{(L_p(t))/q} dt \right)$$

where the Measurement Duration (specified time period) is $T = T_2 - T_1$ and q is the Exchange Rate Factor. Only sound levels above the Threshold Level are included in the integral. *Standard: ANSI S12.19*

Calibration

Adjustment of a sound or vibration measurement system so that it agrees with a reference sound or vibration source. It should be done before each set of measurements.

Decibel (dB)

A logarithmic form of any measured physical quantity, typically used in sound and vibration measurements. Whenever the word *level* is used it implies this logarithmic form. The relationship is relatively simple, but the mathematics can become complex. It is widely

used and was developed so that the very wide range of any quantity could be represented more simply. It is not possible to directly add or subtract physical quantities when expressed in decibel form. The word level is always attached to a physical quantity when it is expressed in decibels; for example L_p represents the sound pressure level. The table below shows the actual value of a specific item, such as sound pressure, for which the level is to be determined. First the value is put into exponential form in powers of ten; the exponent is the Bel. The exponent is then multiplied by ten to yield the decibel. This procedure converts multiplication into addition; every time 10 is *added* to the level, the value is *multiplied* by 10. When the value is not an even multiple of ten the exponent is more complicated as shown in the table. Every time the level increases by 3 dB, the value is multiplied by 2 (doubled). These two rules are worth remembering.

Linear form		Level form
Ration of Value to Reference	Exponential Form of Ratio	10•Exponent
1	10^0	0
10	10^1	10
100	10^2	20
200	$10^{2.3}$	23
1000	10^3	30
10000	10^4	40
100000	10^5	50
1000000	10^6	60

The definition of decibel is intended for power-like quantities (W). Sometimes power is represented by the square of a measured quantity and this results in a different form of the equation (See Sound Pressure Level).

$$L = 10 \log_{10} \left[\frac{W}{W_0} \right] \quad W = W_0 10^{L/10}$$

The value of the item in the table is not the value of the quantity itself but the ratio of that quantity to a reference quantity. So for every level in decibels there must be a reference quantity. When the quantity equals the reference quantity the level is zero. To keep the values

above zero, the reference is generally set to be the lowest value of the quantity.

Detector

The part of a sound level meter that converts the actual fluctuating sound or vibration signal from the microphone to one that indicates its amplitude. It first squares the signal, then averages it in accordance with the time-weighting characteristic, and then takes the square root. This results in an amplitude described as rms (root-mean-square).

Energy Equivalent Sound Level (L_{eq})

The level of a constant sound over a specific time period that has the same sound energy as the actual (unsteady) sound over the same period.

$$L_{eq} = 10 \log_{10} \left[\frac{\int_{T_1}^{T_2} p^2(t) dt}{p_o^2 T} \right]$$

where p is the sound pressure and the Measurement Duration (specific time period) $T=T_2-T_1$. See Sound Exposure Level.

Far Field

There are two types of far fields: the *acoustic* far field and the *geometric* far field.

Acoustic Far Field: The distance from a source of sound is greater than an acoustic wavelength. In the far field, the effect of the type of sound source is negligible. Since the wavelength varies with frequency (See the definition of Wavelength), the distance will vary with frequency. To be in the far field for all frequencies measured, the lowest frequency should be chosen for determining the distance. For example, if the lowest frequency is 20 Hz, the wavelength at normal temperatures is near 56 ft. (17 m); at 1000 Hz, the wavelength is near 1.1 ft. (1/3 m). See the definition of Acoustic Near Field for the advantages of in the acoustic far field.

Geometric Far Field: The distance from a source of sound is greater than the largest dimension of the sound source. In the far field, the effect of source

geometry is negligible. Sound sources often have a variety of specific sources within them, such as exhaust and intake noise. When in the far field, the sources have all merged into one, so that measurements made even further away will be no different. See the definition of Geometric Near Field for the advantages of being in the geometric far field.

Free Field

A sound field that is *free* of reflections. This does not mean that the sound is all coming from one direction as is often assumed, since the source of sound may be spatially extensive. See the definitions of near and far fields for more detail. This definition is often used in conjunction with reverberant field.

Frequency (Hz, rad/sec)

The rate at which an oscillating signal completes a complete cycle by returning to the original value. It can be expressed in cycles per second and the value has the unit symbol Hz (Hertz) added and the letter f is used for a universal descriptor. It can also be expressed in radians per second, which has no symbol, and the greek letter ω is used for a universal descriptor. The two expressions are related through the expression $\omega = 2\pi f$.

Frequency Band Pass Filter

The part of certain sound level meters that divides the frequency spectrum on the sound or vibration into a part that is unchanged and a part that is filtered out. It can be composed of one or more of the following types:

Low Pass: A frequency filter that permits signals to pass through that have frequencies below a certain fixed frequency, called a *cutoff frequency*. It is used to discriminate against higher frequencies.

High Pass: A frequency filter that permits signals to pass through that have frequencies above a certain fixed frequency, called a *cutoff frequency*. It is used to discriminate against lower frequencies.

Bandpass: A frequency filter that permits signals to pass through that have frequencies above a certain fixed frequency, called a lower cutoff frequency, and below a certain fixed frequency, called an *upper cutoff*

frequency. The difference between the two cutoff frequencies is called the *bandwidth*. It is used to discriminate against both lower and higher frequencies so it passes only a band of frequencies.

Octave band: A bandpass frequency filter that permits signals to pass through that have a bandwidth based on octaves. An *octave* is a doubling of frequency so the upper cutoff frequency is twice the lower cutoff frequency. This filter is often further subdivided in 1/3 and 1/12 octaves (3 and 12 bands per octave) for finer frequency resolution. Instruments with these filters have a sufficient number of them to cover the usual range of frequencies encountered in sound and vibration measurements. The frequency chosen to describe the band is that of the center frequency. Note table in Frequency Filter - Frequency Weighting.

Frequency Filter - Weighted

A special frequency filter that adjusts the amplitude of all parts of the frequency spectrum of the sound or vibration unlike band pass filters. It can be composed of one or more of the following types:

A-Weighting: A filter that adjusts the levels of a frequency spectrum in the same way the human ear does when exposed to low levels of sound. This weighting is most often used for evaluation of environmental sounds. See table below.

B-Weighting: A filter that adjusts the levels of a frequency spectrum in the same way the human ear does when exposed to higher levels of sound. This weighting is seldom used. See table below.

C-Weighting: A filter that adjusts the levels of a frequency spectrum in the same way the human ear does when exposed to high levels of sound. This weighting is most often used for evaluation of equipment sounds. See table below.

Flat-Weighting: A filter that does not adjust the levels of

a frequency spectrum. It is usually an alternative selection for the frequency-weighting selection.

Center Frequencies, Hz		Weighting Network Frequency Response		
1/3 Octave	1 Octave	A	B	C
20		-50.4	-24.2	-6.2
25		-44.7	-20.4	-4.4
31.5	31.5	-39.4	-17.1	-3.0
40		-34.6	-14.2	-2.0
50		-30.2	-11.6	-1.3
63	63	-26.2	-9.3	-0.8
80		-22.5	-7.4	-0.5
100		-19.1	-5.6	-0.3
125	125	-16.1	-4.2	-0.2
160		-13.4	-3.0	-0.1
200		-10.9	-2.0	0
250	250	-8.6	-1.3	0
315		-6.6	-0.8	0
400		-4.8	-0.5	0
500	500	-3.2	-0.3	0
630		-1.9	-0.1	0
800		-0.8	0	0
1000	1000	0	0	0
1250		0.6	0	0
1600		1.0	0	-0.1
2000	2000	1.2	-0.1	-0.2
2500		1.3	-0.2	-0.3
3150		1.2	-0.4	-0.5
4000	4000	1.0	-0.7	-0.8
5000		0.5	-1.2	-1.3
6300		-0.1	-1.9	-2.0
8000	8000	-1.1	-2.9	-3.0
10000		-2.5	-4.3	-4.4
12500		-4.3	-6.1	-6.2
16000	16000	-6.6	-8.4	-8.5
20000		-9.3	-11.1	-11.2

L_{eq}

See “Energy Equivalent Sound Level”, “Sound Level”, “Energy Average”, and “Time Weighted Average”

Level (dB)

A descriptor of a measured physical quantity, typically used in sound and vibration measurements. It is attached to the name of the physical quantity to denote that it is a logarithmic measure of the quantity and not the quantity itself. The word *decibel* is often added after

the number to express the same thing. When frequency weighting is used the annotation is often expressed as dB(A) or dB(B).

Measurement Duration (T)

The time period of measurement. It applies to hearing damage risk and is generally expressed in hours.

Standard: ANSI S12.19

Microphone Guidelines

Microphone - Types: A device for detecting the presence of sound. Most often it converts the changing pressure associated with sound into an electrical voltage that duplicates the changes. It can be composed of one of the following types:

Capacitor (Condenser): A microphone that uses the motion of a thin diaphragm caused by the sound to change the capacitance of an electrical circuit and thereby to create a signal. For high sensitivity, this device has a voltage applied across the diaphragm from an internal source.

Electret: A microphone that uses the motion of a thin diaphragm caused by the sound to change the capacitance of an electrical circuit and thereby to create a signal. The voltage across the diaphragm is caused by the charge embedded in the electret material so no internal source is needed.

Microphone - Uses: The frequency response of microphones can be adjusted to be used in specific applications. Among those used are:

Frontal incidence (Free Field): The microphone has been adjusted to have an essentially flat frequency response when in a space relatively free of reflections and when pointed at the source of the sound.

Random incidence: The microphone has been adjusted to have an essentially flat frequency response for sound waves impinging on the microphone from all directions.

Pressure: The microphone has not been adjusted to have an essentially flat frequency response for sound waves impinging on the microphone from all directions.

What a microphone measures: *A microphone detects more than just sound.* The motion of a microphone diaphragm is in response to a force acting on it. The force can be caused by a number of sources only one of which are we interested: sound. Non-sound forces are: (1) direct physical contact such as that with a finger or a raindrop; (2) those caused by the movement of air over the diaphragm such as environmental wind or blowing; (3) those caused by vibration of the microphone housing; and (4) those caused by strong electrostatic fields.

Rules:

1. Do not permit any solid or liquid to touch the microphone diaphragm. Keep a protective grid over the diaphragm.
2. Do not blow on a microphone and use a wind screen over the microphone to reduce the effect of wind noise.
3. Mount microphones so their body is not subject to vibration, particularly in direction at right angles to the plane of the diaphragm.
4. Keep microphones away from strong electrical fields.

A microphone measures forces not pressures. We would like the microphone to measure sound pressure (force per unit area) instead of sound force. If the pressure is applied uniformly over the microphone diaphragm a simple constant (the diaphragm area) relates the two, but if the pressure varies across the diaphragm the relationship is more complex. For example, if a negative pressure is applied on one-half the diaphragm and an equal positive pressure is applied to the other half, the net force is zero and essentially no motion of the diaphragm occurs. This occurs at high frequencies and for specific orientations of the microphone.

Rules:

1. Do not use a microphone at frequencies higher than specified by the manufacturer; to increase the frequency response choose smaller microphones.
2. Choose a microphone for *free field* or *random incidence* to minimize the influence of orientation.

A microphone influences the sound being measured. The microphone measures very small forces, low level sound can run about one-billionth of a PSI! Every measurement instrument changes the thing being measured, and for very small forces that effect can be

significant. When sound impinges directly on a microphone the incident wave must be reflected since it cannot pass through the microphone. This results in the extra force required to reflect the sound and a microphone output that is higher than would exist if the microphone were not there. This is more important at high frequencies and when the microphone is facing the sound source.

Rules:

1. Do not use a microphone at frequencies higher than specified by the manufacturer; to increase the frequency response choose smaller microphones.
2. Choose a microphone for *free field* or *random incidence* to minimize the influence of orientation.

A microphone measures what is there from any direction: Most measurements are intended to measure the sound level of a specific source, but most microphones are not directional so they measure whatever is there, regardless of source.

Rules:

1. When making hand-held measurements, keep your body at right angles to the direction of the sound you are interested in and hold the meter as far from your body as possible. Use a tripod whenever possible.
2. Measure the influence of other sources by measuring the background sound level without the source of interest. You may have to correct for the background.

Near Field

There are two types of near fields: the *acoustic near field* and the *geometric near field*.

Acoustic Near Field: The distance from a source of sound is less than an acoustic wavelength. In the near field, the effect of the type of sound source is significant. Since the wavelength varies with frequency (See the definition of Wavelength), the distance will vary with frequency. The most common example of a near field is driving an automobile with an open window. As you move your ear to the plane of the window, the sound pressure level builds up rapidly (wind noise) since most of the pressure changes are to move the air and very little of it compresses the air to create sound. Persons not far away, can hardly hear what you hear. The acoustic near field is characterized by pressures that do not create sound that can be measured in the

far field. Therefore measurements made here are not useful in predicting the sound levels far way or the sound power of the source.

Geometric Near Field: The distance from a source of sound is less than the largest dimension of the sound source. In the near field, effect of source geometry is significant. Sound sources often have a variety of specific sources within them, such as exhaust and intake noise. When in the near field, the sound of a weaker, but close, source can be louder than that of a more distant, but stronger, source. Therefore measurements made here can be used to separate the various sources of sound, but are not useful in predicting the sound levels and sound spectrum far from the source.

Noise

Typically it is *unwanted* sound. This word adds the response of humans to the physical phenomenon of sound. The descriptor should be used only when negative effects on people are known to occur. Unfortunately, this word is used also to describe sounds with no tonal content (random):

Ambient: The all encompassing sound at a given location caused by all sources of sound. It is generally random, but need not be.

Background: The all encompassing sound at a given location caused by all sources of sound, but excluding the source to be measured. It is essentially the sound that interferes with a measurement.

Pink: It is a random sound that maintains constant energy per octave. Pink light is similar to pink noise in that it has a higher level at the lower frequencies (red end of the spectrum).

White: It is a random sound that contains equal energy at each frequency. In this respect, it is similar to white light.

Sound

The rapid oscillatory compressional changes in a medium (solid, liquid or gas) that propagate to distant points. It is characterized by changes in density, pressure, motion, and temperature as well as other physical quantities. Not all rapid changes in the medium are sound (wind noise) since they do not propagate.

The auditory sensation evoked by the oscillatory changes.

Difference between sound and noise: Sound is the physical phenomenon associated with acoustic (small) pressure waves. Use of the word *sound* provides a neutral description of some acoustic event. Generally, noise is defined as unwanted sound. It can also be defined as sound that causes adverse effects on people such as hearing loss or annoyance. It can also be defined as the sound made by other people. In every case, noise involves the judgment of someone and puts noise in the realm of psychology not physics.

Rules:

1. Use word *sound* to describe measurements to remove the emotional overtones associated with the word *noise*. Some sound metrics use noise in their name and it is proper to use the name as it is.

Sound Pressure

The physical characteristic of sound that can be detected by microphones. Not all pressure signals detected by a microphone are sound (e.g., wind noise). It is the amplitude of the oscillating sound pressure and is measured in Pascals (Pa), Newtons per square meter, which is a metric equivalent of pounds per square inch. To measure sound, the oscillating pressure must be separated from the steady (barometric) pressure with a detector. The detector takes out the steady pressure so only the oscillating pressure remains. It then squares the pressure, takes the time average, and then takes the square root (this is called rms for root-mean square). There are several ways this can be done.

Moving Average: The averaging process is continually accepting new data so it is similar to an exponential moving average. The equation for it is

$$p_{rms} = \sqrt{\frac{1}{T} \int_{t_s}^t p^2(\xi) e^{-(t-\xi)/T} d\xi}$$

The sound pressure is squared and multiplied by an exponential decay factor so that when the time of integration is near the current time (t) it is essentially undiminished. For times older (less) than the current time, the value is diminished and so becomes less important. The rate at which older data are made less influential is expressed by the constant T. The larger is it the slower the decay factor reduces and the slower the response of the system to rapid changes. These are standardized into three values called Time Weighting. See the values below.

Fixed Average: The averaging process is over a fixed time period. The equation for it is

$$p_{rms} = \sqrt{\frac{1}{(T_2 - T_1)} \int_{T_1}^{T_2} p^2(t) dt}$$

The sound pressure is squared and averaged over a fixed time period. Unlike the moving average, the sound pressures in all time intervals are equally weighted.

Sound Pressure Level (SPL, L_p)

The logarithmic form of sound pressure. It is also expressed by attachment of the word decibel to the number. The logarithm is taken of the ratio of the actual sound pressure to a reference sound pressure which is 20 MicroPascals (μ Pa). There are various descriptors attached to this level depending on how the actual sound pressure is processed in the meter:

Instantaneous: The time varying reading on a meter face on in a meter output due to changes in the sound pressure. The reading will depend on the time-weighting applied.

The fundamental relationship between the two is logarithmic

$$L_p = 20 \log_{10} \left[\frac{p_{rms}}{p_0} \right] \quad p_{rms} = p_0 10^{L_p/20}$$

where p_0 is the reference sound pressure of 20 μPa . The square of the sound pressure is a power-like quantity that can be expressed in the original form of the level definition

$$L_p = 10 \log_{10} \left[\frac{p_{rms}^2}{p_0^2} \right] \quad p_{rms}^2 = p_0^2 10^{L_p/10}$$

Sound Pressure Level can be converted to sound pressure as follows. If the sound pressure is 1 Pascal, then the sound pressure level is

$$20 \log_{10} \left[\frac{1}{20 \bullet 10^{-6}} \right] = 20 \log_{10} [50000] = 20 [4.699] = 94.0 \text{ dB}$$

Calibrators often use a level of 94 dB so they generate a sound pressure of 1 Pascal.

If the sound pressure level = 76.3 dB, then the sound pressure is

$$10^{76.3/20} = 20 \bullet 10^{3.815-6} = 20 \bullet 10^{-2.185} = 20 [0.0065] = 0.13$$

Energy Average (L_{eq}): The value of a steady sound measured over a fixed time period that has the same sound energy as the actual time varying sound over the same period. This descriptor is widely used. It is a fixed average (See Sound Pressure).

Impulse: The value of an impulsive sound. The reading will depend on the time-weighting applied.

Unweighted Peak: The peak value of a sound with a meter that has flat frequency weighting and a peak detector.

Weighted Peak: The peak value of a sound with a meter that has a frequency weighting other than flat and a peak detector.

Sound Speed, (c,)

The speed at which sound waves propagate. It is measured in meters per second. It should not be confused with sound or particle velocity which relates to the

physical motion of the medium itself.

$$c = 20.05 \sqrt{\text{degC} + 273} \quad \text{m/s}$$

$$c = 49.03 \sqrt{\text{degF} + 460} \quad \text{ft/sec}$$

Spectrum (Frequency Spectrum)

The amplitude of sound or vibration at various frequencies. It is given by a set of numbers that describe the amplitude at each frequency or band of frequencies. It is often prefixed with a descriptor that identifies it such as sound pressure spectrum. It is generally expressed as a spectrum level.

Time Weighting

The response speed of the detector in a sound level meter. There are several speeds used.

Slow: The time constant is 1 second (1000 ms). This is the slowest and is commonly used in environmental noise measurements.

Fast: The time constant is 1/8 second (125 ms). This is a less commonly used weighting but will detect changes in sound level more rapidly.

Impulse: The time constant is 35ms for the rise and 1.5 seconds (1500 ms) for the decay. The reason for the double constant is to allow the very short signal to be captured and displayed.

Vibration

The oscillatory movement of a mechanical system (generally taken to be solid). It is used as a broad descriptor of oscillations.

Wavelength (l)

The distance between peaks of a propagating wave with a well defined frequency. It is related to the frequency through the following equation

$$\lambda = \frac{c}{f}$$

where c is the sound speed and f is the frequency in Hz. It has the dimensions of length.

Wavenumber (k)

A number that is related to the wavelength of sound and is used to compare the size of objects relative to the wavelength or the time delay in sound propagation. It is related to wavelength through the following equation

$$k = \frac{2\pi}{\lambda} = \frac{2\pi f}{c} = \frac{\omega}{c}$$

where λ is the wavelength, c is the sound speed, f is the frequency in Hz, and ω is the radian frequency. It has the dimensions of inverse length.

E

Warranty/Customer Satisfaction

A. Total Customer Satisfaction. Larson Davis, Inc. ("LD") guarantees Total Customer Satisfaction. If, at any time you are not completely satisfied with any LD product, LD will repair, replace or exchange it at no charge, except as otherwise provided in this Limited Warranty. The employees of LD strive to provide superior, unmatched customer service. Should you find yourself dissatisfied with any LD product for any reason, consult a LD Application engineer or local representative/ distributor to discuss your situation.

B. Purchase Price Refund/Limited Warranty. LD warrants to the original purchaser (the "Buyer") that, unless otherwise expressly specified in writing by a LD officer, all LD products shall be free of defects in material and workmanship for a period of two (2) years from date of original purchase. In furtherance of LD's commitment to Total Customer Satisfaction, LD will, for a period of one (1) year from date of original purchase, refund 100% of the customer's purchase price for any LD product with which the buyer is not completely satisfied, subject to the exceptions contained in Paragraph J of this Limited Warranty. The option of a refund may be selected during this one (1) year period in lieu of repair, replacement or exchange of the product.

Extended Labor Warranty. In furtherance of LD's commitment to Total Customer Satisfaction, LD offers an extended labor warranty of one (1) year on all products calibrated or certified by a factory technician at any time or from time-to-time during the first seven years of the product life from date of manufacture. The customer's sole remedy pursuant to this extended warranty is to receive free labor for any repairs required during the period in which the extended warranty is effective. This extended labor warranty is subject to the limitations as outlined in Paragraph J.

Service & Repair Limited Warranty. In addition to the limited warranties set forth above, LD offers a 90-day parts and labor limited warranty for all repair work performed at the factory. This warranty is limited to parts repaired or replaced at the factory by LD. This warranty is also subject to the limitations as outlined in Paragraph J.

C. Shipping Charges. The buyer will return the product freight prepaid by the Buyer to an authorized service center. The product will be returned to the buyer freight prepaid by LD.

D. Products Manufactured by Others. This Limited Warranty does not cover any products manufactured by others. Such products are subject to the warranty, if any, of their respective manufacturers, and to be repaired only by a respective authorized service person for such products. LD shall have no obligation to undertake repairs of products manufactured by others.

E. NO SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES. LD'S SOLE OBLIGATIONS UNDER THIS LIMITED WARRANTY ARE SET FORTH ABOVE IN PARAGRAPHS A, B, C AND D. IN NO EVENT SHALL LD (ITS CONTRACTORS OR SUPPLIERS) BE LIABLE TO THE BUYER FOR ANY LOST PROFITS, DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, IN TORT OR ANY OTHER LEGAL THEORY. SUCH DAMAGES FOR WHICH LD SHALL NOT BE RESPONSIBLE INCLUDE, BUT ARE NOT LIMITED TO, LOST TIME AND CONVENIENCE, LOSS OF USE OF THE PRODUCT, THE COST OF A PRODUCT RENTAL, COSTS OF GASOLINE, TELEPHONE, TRAVEL OR LODGING, THE LOSS OF PERSONAL OR COMMERCIAL PROPERTY, AND THE LOSS OF REVENUE.

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H. WAIVER OF OTHER WARRANTIES. THE EXPRESS WARRANTIES SET FORTH IN THIS LIMITED WARRANTY ARE IN LIEU OF AND EXCLUDE ANY AND ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

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I. Procedure for Warranty Performance. If the product fails to perform to LD's specifications, the Buyer must provide LD with the applicable model and serial numbers, the date of purchase, and the nature of the problem.

J. ADDITIONAL EXCLUSIONS FROM THIS LIMITED WARRANTY. NOTWITHSTANDING ANYTHING TO THE CONTRARY CONTAINED IN THIS LIMITED WARRANTY, THIS LIMITED WARRANTY DOES NOT COVER ANY OF THE FOLLOWING:

1.EQUIPMENT THAT HAS BEEN ABUSED, DAMAGED, USED BEYOND RATED CAPACITY, OR REPAIRED BY PERSONS OTHER THAN AUTHORIZED SERVICE PERSONNEL.

2.DAMAGE CAUSED BY ACTS OF GOD THAT INCLUDE, BUT ARE NOT LIMITED TO, HAILSTORMS, WINDSTORMS, HURRICANES, TORNADOES, SANDSTORMS, LIGHTNING, FLOODS AND EARTHQUAKES.

3.DAMAGE UNDER CONDITIONS CAUSED BY FIRE OR ACCIDENT, BY ABUSE OR BY NEGLIGENCE OF THE USER OR ANY OTHER PERSON OTHER THAN LD, BY IMPROPER INSTALLATION, BY MISUSE, BY INCORRECT OPERATION, BY “NORMAL WEAR AND TEAR”, BY IMPROPER ADJUSTMENT OR ALTERATION, BY ALTERATIONS NOT COMPLETED BY AUTHORIZED SERVICE PERSONNEL, OR BY FAILURE OF PRODUCTS PARTS FROM SUCH ALTERATIONS.

4.COSTS OF REPAIRING DAMAGE CAUSED BY POOR OR IMPROPER MAINTENANCE OR UNAUTHORIZED REPAIR.

5.COSTS OF MODIFYING THE PRODUCT IN ANY WAY ONCE DELIVERED TO THE BUYER, EVEN IF SUCH MODIFICATIONS WERE ADDED AS A PRODUCTION CHANGE ON OTHER PRODUCTS MADE AFTER THE BUYER'S PRODUCT WAS BUILT.

Authority to Alter This Limited Warranty. No agent, representative, distributor, or authorized dealer of LD has any authority to alter the terms of this Limited Warranty in any way. This Limited Warranty may be altered only in a writing signed by an authorized officer of LD.

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